Engineering News

Volume 77, No. 8
Issued Every Thursday
Hill Publishing Company

NEW YORK, FEBRUARY 22, 1917

Price, 15 Cents
Contents, First Page
Advertising Index, Last Page

Engineering Library

FEB 23 1917

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Asbestosteel

for Roofs and Walls

Details of
Asbestosteel Construction

What is it?

The *core* is of Asbestos Protected Metal sheets rectangularly corrugated.

Then—reinforced concrete or gypsum.

On top—the usual waterproofing.

Laid directly on—steel purlins.

Back plastering?—not required.

Result—permanent construction.

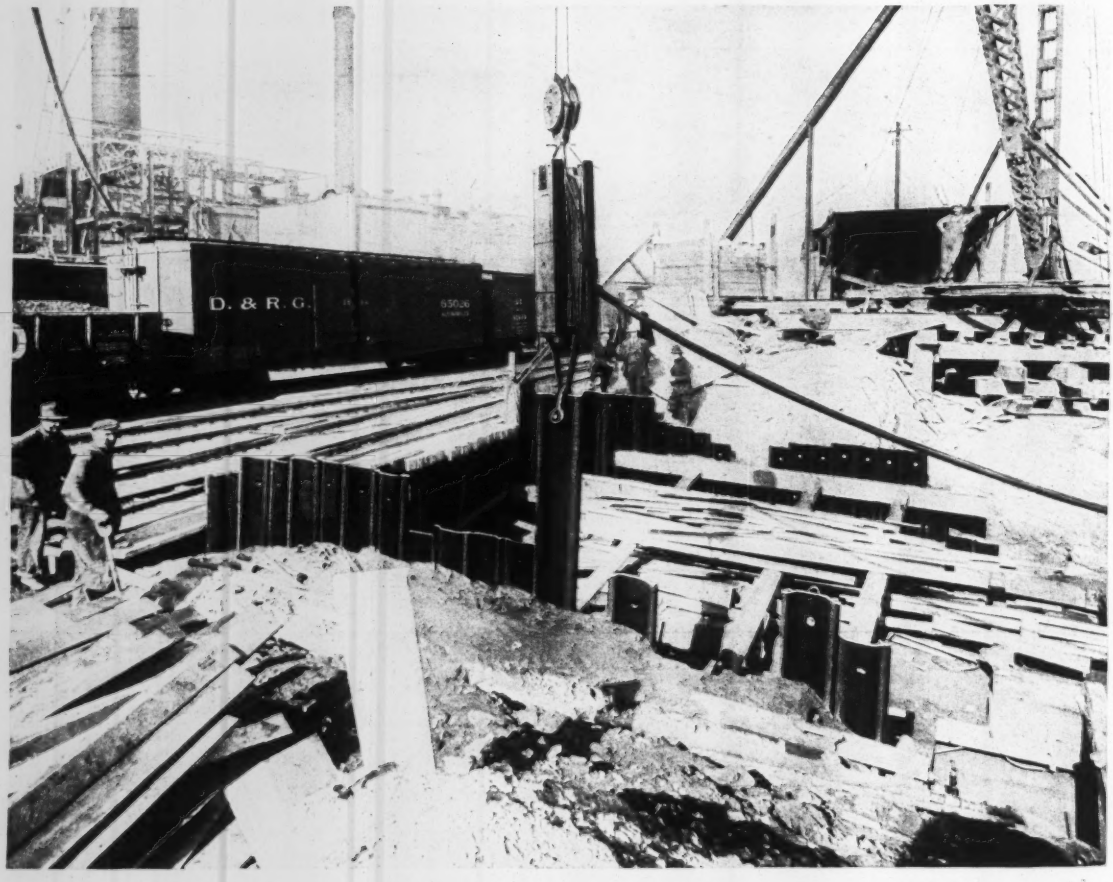
The details—are in Bulletin No 548.

APM Asbestos Protected Metal Co.
Pittsburgh
First National Bank Building

For Canada: Canadian Asbestos Co., Montreal.
England: Dock House, Billeter Street, London.

Drill Hall, Cornell University, Ithaca, N. Y.
Asbestosteel Roofing

2063



Lackawanna Steel Sheet Piling Used in Construction of Intake and Discharge Tunnels at the Power Station of the Omaha (Neb.) Electric Light & Power Company.

These tunnels are built on bed-rock and at the outer end in the Missouri River are about 35 feet below the water level. Their construction necessitated the removal of about 10 feet of stiff clay at the surface and below that, fine quicksand down almost to bed rock.

The cofferdams which were driven to permit excavation were made from the Lackawanna 14-inch Arched-Web section in lengths of 30 feet and over. The Jarrett-Chambers Co. of New York, construction managers of the work, tell us that the sheet piling sections all drove without great difficulty.

Now that much of this sheet piling has served its purpose and done so very well, some has already been pulled, and it is the intention of the contractors to reuse all reclaimed sections in another installation.

Contractors who appreciate certainty of good performance, minimum delays, saving in labor and bracing and the cooperation of our thoroughly experienced engineers will find Lackawanna Steel Sheet Piling most helpful and economical equipment.

Write for our book, "Lackawanna Steel Sheet Piling."

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Licensees for the manufacture of Lackawanna Steel Sheet Piling:

For Great Britain and British Colonies in the Eastern Hemisphere, Cargo-Fleet-Iron Co., Ltd., Middlesbrough, England. For France, Italy, Spain, French Colonies and Protectorates, Italian Colonies and Spanish Colonies in the Eastern Hemisphere: Cie Des Forges & Aciéries de la Marine et d'Homécourt, Paris, France.

Engineering News

VOLUME 77 FEBRUARY 22, 1917 NUMBER 8

Ship Canal from Swedish Lake to Ocean

A barge or ship canal connecting one of the large lakes of Sweden with an ocean port has just been completed, after seven years of work. The canal is known as the Trollhattan Canal and connects Lake Vener, in the southwestern part of Sweden, with the port of Gothenburg, which is located on the Cattegat, the strait connection between the Baltic and the North Sea. The project was started by investigations in 1902, and actual construction was begun in 1909. Official ceremonies opened the work in October, 1916.

The new canal, which is an enlargement of one of some years' standing, is 52 mi. long, 47 mi. of which is the canalization of the Gota River. From the lake to the sea level there is a difference of head of 145 ft., which is distributed among six locks. The canal is designed at present to carry vessels of a draft of 13.2 ft., though it is eventually intended to be deepened to carry vessels of a draft of 16.4 ft. On account of the eventual depth, a number of the rock excavations have been carried down to the full depth, and the locks have been built for future contingencies. The minimum bottom width of the canal is about 80 ft., with wide turnouts provided at intervals. The excavation in rock is on a slope of 10:1 and in earth on a slope of 1:2. The minimum width of the lock gates is 45 ft., and the length of the lock chambers is 296 ft. The minimum depth over the sill of the locks is 18 ft.

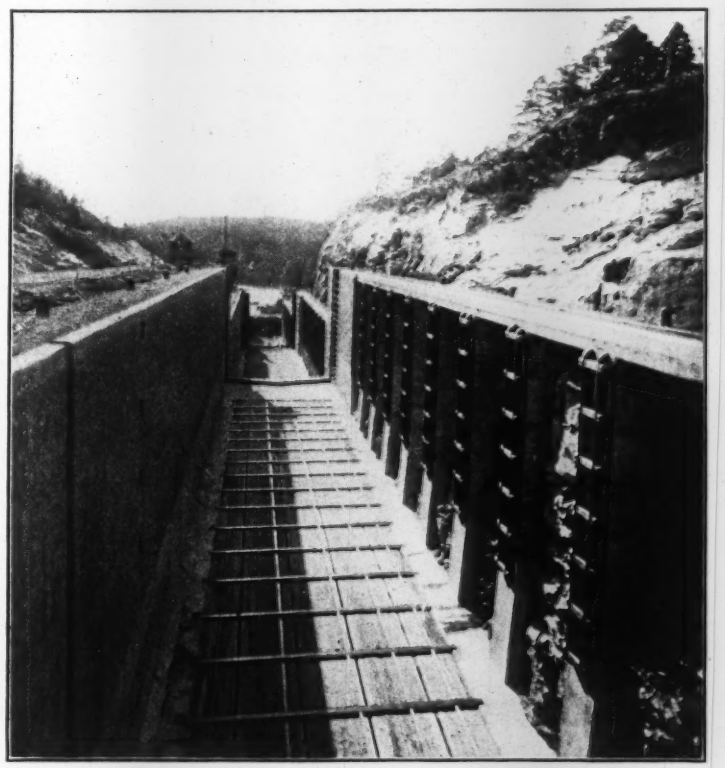

FIG. 1. LOOKING DOWN A FLIGHT OF THREE LOCKS AT TROLLHATTAN, ON THE TROLLHATTAN CANAL IN SWEDEN

Excavation totaled about 5,390,000 yd., distributed as follows: Soil excavation, 930,000 cu.yd.; total rock excavation, 1,360,000, of which 34,000 is below water; dredging, 3,100,000 cu.yd.

Six locks are required to take care of the difference in head, two of them at either end of the canal and four at the town of Trollhattan, the site of the famous water-power development. Of these four locks, three are joined in one flight. The view in Fig. 1 is taken from the uppermost of the three locks, looking down toward the lower level. The locks vary in difference of level from 18 to 31 ft. They are of concrete masonry; but in some cases where they are built through the solid rock cut, the side against the rock is not completely sheathed with concrete, but is merely provided with piers on which guard timbers are placed. This is very well illustrated in Fig. 1.

The lock chambers can be supplied with and emptied of water by lateral culverts arranged in the masonry on the sides of the gate chambers. These culverts are placed on either side of the lock basin, as a rule, and inlet culverts open into a crib arranged under the upper gate chamber in each lock. From this crib a bottom channel leads under the bottom of the lock, from which the water flows out into the lock. Outlet tunnels proceed likewise through the bottom channel. The flow of water in the lateral culverts is regulated by vertical valves. When it is necessary to repair the valves, the lateral culverts can be shut off separately by means of sliding timbers. The lock gates are mitered and are driven, like the valves, by means of electric machinery placed in the chambers in the lateral masonry and sunk under the plane of the lock. The locks are moreover provided with electrically driven capstans, windlasses and other operating machinery, with appliances for shutting off the locks and with electric illumination and signalling apparatus. All the electric machinery, except the capstans, and all the illumination and signal lights are operated from boxes erected on the lock planes.

While it is expected that some self-operated boats will run in the canal, in order to facilitate the towing of sailing vessels and barges a towpath has been arranged

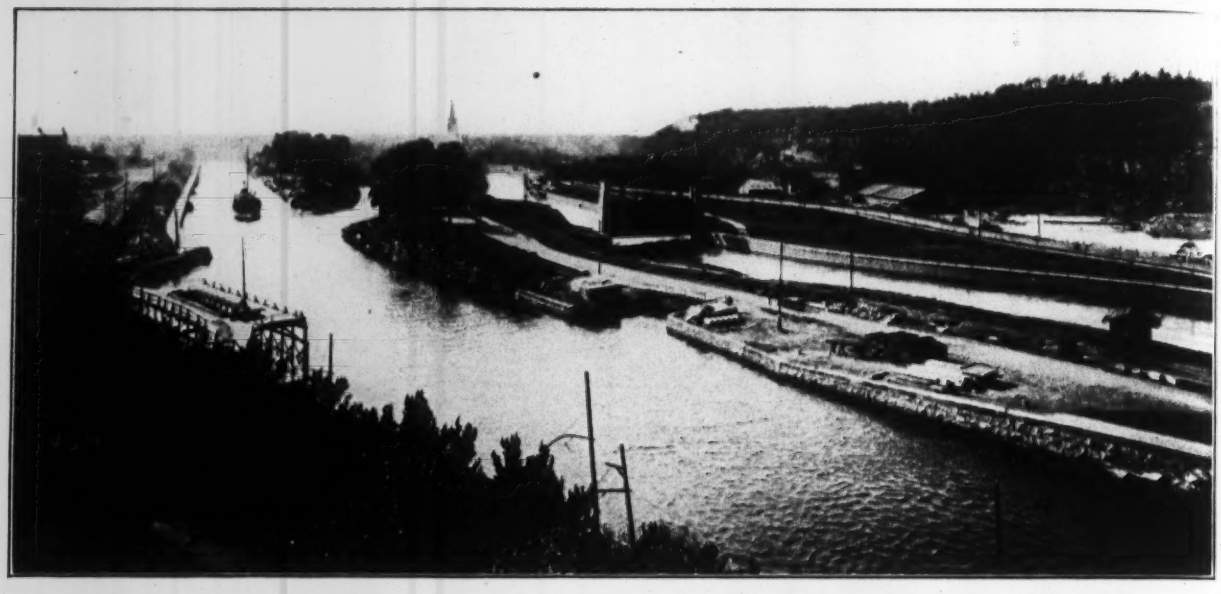

FIG. 2. THE TROLLHATTAN IRRIGATION CANAL IN SOUTHWEST SWEDEN
The navigation canal on the left, the power canal in the middle and the Gota River in the rear

along one side of the canal. Full provision for navigation has been made in the way of signals, lighthouses, drawbridges at the principal railway and road crossings, harbors at the different towns that are passed, breakwaters in the lakes, and regulating dams at two places.

Fig. 2, taken at Trollhattan, shows the completed canal as it appeared last fall. The navigation canal is to the left, the famous Trollhattan power canal is in the middle of the picture, and the river is in the background. One of the harbors, that at Akersberg, is shown in Fig. 3.

The superintendence for the entire work was in the hands of the Director-General of Waterfalls of Sweden, Col. F. Z. Hansen. The immediate construction was under charge of Capt. G. Maln, of the Corps of Royal Engineers, and later of Lieut. A. Ekwall, of the same corps, who succeeded Captain Maln in 1911. The information on the canal, together with photographs, some of which are reproduced here, was kindly forwarded to us by K. A. Froman, the chief assistant engineer of the canal work. Mr. Froman's report also states that by a bill passed late last year the Swedish Parliament voted a grant for the beginning of the extension of a canal connecting the Baltic and Lake Malar, at one end of which Stockholm is situated. When the reconstruction of this canal has been completed, the two largest lakes of Sweden will be accessible to modern seagoing vessels. A further project that is under consideration is the building of a canal connecting Lake Malar with Lake Vener.

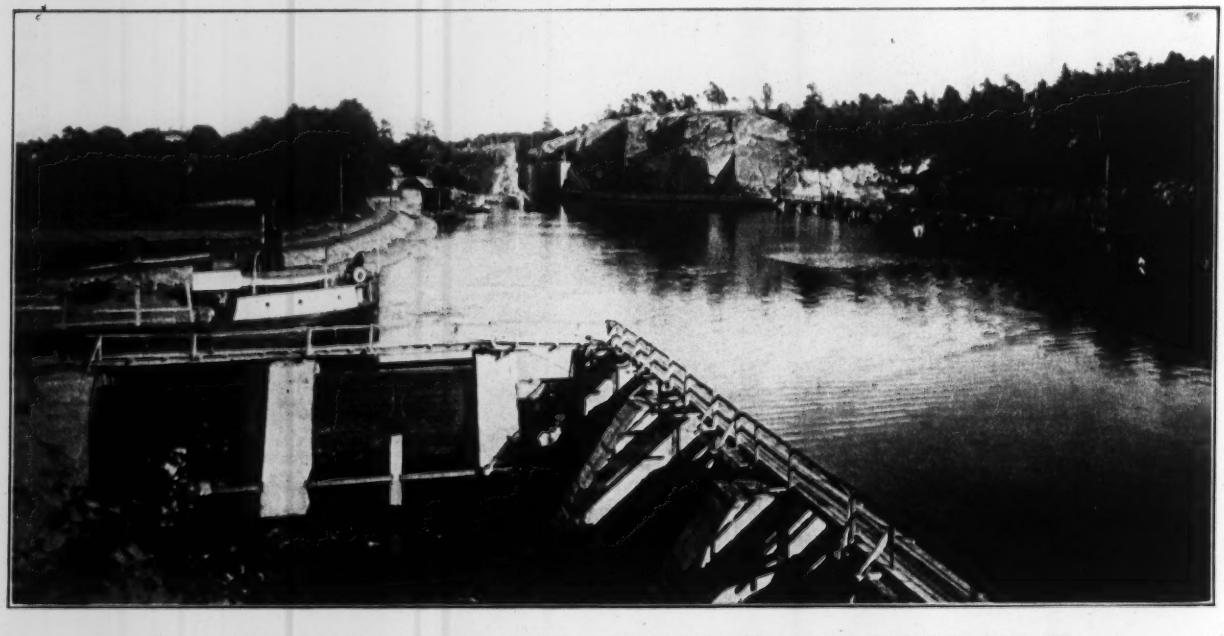

FIG. 3. A DOCK AND LOCK BASIN ON THE NEW TROLLHATTAN SHIP CANAL IN SWEDEN

The Art of the Expert Witness

SYNOPSIS—A well-known engineer who has appeared as an expert witness in many court and informal cases, here writes his observations on securing good testimony that will win the satisfaction of clients and the respect of opponents. This article deals with the engineer on the witness stand in court. A subsequent article discusses differences in opinions and findings of fact between experts.

I. On the Stand

Nearly all engineers are called upon sooner or later to speak as experts in connection with some engineering matter. Expert testimony is a subject on which very little has been written. It appears that engineers equally qualified in other respects differ greatly in their ability or effectiveness as expert witnesses. There is no reason why engineers should not seek to attain the highest possible efficiency as expert witnesses when called upon to act in that capacity, just as they would seek to attain the highest efficiency in engineering design or construction work.

Possibly the use of the word efficiency, applied to the work of an expert witness, is somewhat novel; therefore, the following definition is given:

Efficiency on the part of an expert witness is the ability to get before the court or judicial body the facts or opinions involved in his testimony—clearly, correctly, completely.

What the Expert Is For

It is a fact that many excellent engineers make very poor expert witnesses. Probably in large measure this is due to failure of the engineer when appearing as a witness to realize the peculiar conditions under which he is then working. First, the witness is presenting the results of his studies or experience, not to engineers, but to men whom he must assume are wholly ignorant of technical matters and whose whole mental processes are different from his own.

In the second place, he must bear in mind that he is not at liberty to state his opinions in what very likely appears to him to be a natural, orderly and consistent manner, but rather he must get his testimony before the court in answer to a series of questions which may come to him in a very different order from that in which he would ordinarily make his own statements.

Above all, the expert witness must constantly bear in mind that his testimony is being presented for the information of the court; that the court, as a rule, has a high degree of intelligence and is not hampered by prejudice for either side; but that it is not a technical court and requires very clear, and often full, explanations of technical matters in order to grasp their proper significance and bearing.

Knowledge and Ability

There is another and a different reason why many excellent engineers do not make good experts. Success in engineering, as in many other things, is often attained mainly through concentration. The engineer who has devoted himself exclusively, we will say, to some specific class of work in a particular locality, however successful he may have been, may make a very poor witness as to general principles and facts and conditions underlying the design, efficiency or cost of similar work elsewhere.

The reason is that an expert to make a good witness must, in general, be very broadly conversant with the subject with which he is dealing. He must be capable of distinguishing instantly between broad generalities and specific instances. The man whose work has been concentrated along a certain line is much less apt to possess this ability than one whose practice has been perhaps more superficial, but which has covered a wider range and consequently enables him to view from a variety of different angles every possible question involved.

A primary requisite of success as an expert witness appears to be therefore a broad and thorough knowledge of the subject upon which the witness is appearing. There is nothing that can give a witness a greater degree of self-possession or fuller confidence as he squares himself for cross-examination on the witness stand than the feeling that he knows what he is going to talk about and knows it better than anyone else present—better than the attorneys who cross-examine him can possibly know it.

Even if the witness possesses in full the qualifications of knowledge and experience, he will often leave the witness stand, after his first experience, with a feeling of great dissatisfaction, especially if the opposing counsel who cross-examines him is sharp and subtle. As in most other lines of personal effort, a high degree of efficiency can be attained only as the result of practical experience. Given the primary qualifications of knowledge, ability, self-control, a certain amount of adroitness and a good understanding of human nature, still the engineer appearing as an expert can, if he will, profit greatly along the following lines as the result of experience. A little study will quicken the process.

Rules of Evidence

He may learn much of the rules of evidence, so that he will know when to qualify and when not to qualify his answers. He may learn the art of making his answers complete and unequivocal and at the same time direct and wholly responsive. On cross-examination some questions call for yes or no answers, and others do not. Questions that can fairly be answered by yes or no should in general be so answered. The witness who unnecessarily qualifies his answers runs the risk either of creating an unfavorable impression with the court, or of having portions of his answers striken out as not responsive.

On the other hand if, as often happens, the cross-examining attorney is attempting to create a false impression by a series of questions, then a qualified answer is not always unjustified. Even if afterward stricken out, it may call the attention of the court to the unfairness of the questions.

Circumstances alter cases. An expert witness subjected to unfair questions sometimes properly takes the bit in his teeth and runs away with the cross-examining attorney. The latter has the power, by virtue of his position and under the rules of evidence, of mistreating an inexperienced but fair-minded witness. Certainly, a fair-minded witness is entitled to resort to somewhat extreme methods

to protect himself against browbeating and insinuation. Judges seem generally to prefer that a witness should take care of himself rather than continually appeal to the court for protection.

The object of qualifying an answer is to put the truth in its proper relations. A witness is asked to state the minimum flow of a stream, where it is evident that the natural or unregulated flow is intended, but is not so stated in the question. The witness may have seen the stream dry under artificial conditions, and there are therefore two answers that he may give. Answering literally, he may say zero. Assuming that the intent of the question is to get at the natural minimum yield, he may give the latter figure. Either answer is likely to lead to complications. The question, as put, is at fault because it does not clearly distinguish which is intended—the natural or the artificial minimum. The witness should either clear this up by asking a question preliminary to his answer or else should qualify his answer by stating to which it refers.

If a witness cannot answer a question in such a way as to tell the whole truth by the word yes or no, he is entitled to say so. Nevertheless, the presiding judge not infrequently will be of the opinion that the question is one that may fairly and properly be answered by yes or no and insist upon such an answer. Under these conditions there is no reason why a witness should not supply the answer, for it is already on the record that his answer is under protest, implying that there is some qualification necessary. The witness must, however, depend upon the counsel for his own side of the case to give him an opportunity to make the desired qualification to his anwer later on, on redirect examination. Some attorneys seem never to miss an opportunity to engage in a so-called fishing expedition in the cross-examination of an expert, while others confine their cross-examinations to brief and pertinent matters and, following the advice of an old trial lawyer, "do not attempt to plow with their adversaries' oxen."

Definiteness To Be Sought

Another point where inexpert witnesses often fall short is in the matter of definiteness. Testimony that a certain distance is a long distance, or that a certain well is a deep well, is bad enough even when coming from lay witnesses. Attorneys on both sides often try in vain to get witnesses to give definite statements in such cases. The experienced expert witness will know beforehand that he is quite certain to be called upon for a definite statement; he will give the matter forethought and be prepared. But suppose that the witness has not done so and does not actually know, for example, the distance between two points. One of the attorneys will ask him to give his best judgment. Perhaps the witness will say he does not know and has no judgment. Still the attorney may persist, "Well, you know it is not a hundred miles, don't you?" and the witness will reply, "Yes." Then the attorney will ask: "Is it more than one mile?" and the witness will reply "Yes." Proceeding by successive increments, the attorney will worm out of the witness a guess as to the distance involved. Very likely, when the opposing counsel's turn comes he will ask: "That was nothing but a guess?" to which the witness will say, "Yes." The net result is that a great deal of time and labor has been expended in getting the witness to give an answer that he might as well have given as a guess, so stated, in the first instance.

There is another class of judgments that a witness is often called upon to give upon the witness stand which deserves some attention, and that is estimates on matters capable of measurement, but which the witness, owing to his special knowledge or experience, is competent to estimate closely without actual measurements, such, for example, as the amount of masonry in a wall that the witness has examined carefully, but has not measured.

Having given his estimate, the opposing counsel is very likely to insist upon an admission by the witness that this estimate is purely a guess. In general, such an admission should not be made. The witness should have clearly in mind the distinction between guesses, estimates and actual measurements.

The mathematical definition of a guess is: A judgment that the probability of an event lies midway between the two possible extremes, made in the total absence of any knowledge of causes tending to vary it one way or the other. It is the value of the event that would have a probability of one-half in accordance with the principle of insufficient reason.

An estimate is a judgment of the most probable value of an event or a quantity where there are some known elements that may affect the position of its value between the possible extremes, all these elements being taken into account. Precisely speaking, of course, a guess is a judgment and so is an estimate; but practically, a guess is never an estimate, although estimates vary in value from those which are only as good as guesses to those which are nearly equal to actual measurements.

As illustrating the difference between guesses and estimates, let it be required to determine the distance between two points that lie somewhere within a circle 2 ft. in diameter. The points cannot be more than 2 ft. apart, and they may be in juxtaposition. If their locations are wholly unknown, the best possible guess as to their position is that they are 1 ft. apart. If their location is known, but the distance between them has not been measured, an estimate of the distance may often be made that will be very close to the truth, by comparing their apparent distance with some fixed scale or unit of measurement, such, for example, as the diameter of the circle. Thus an estimate is based upon some scale of comparison, while a guess is not so based.

Calculations Made on the Stand

Many experts absolutely refuse, unless compelled by the court, to make calculations on the witness stand. If the expert has before him the necessary data and the calculation is one that can be quickly made, there is no reason why he should refuse to make the calculation on the witness stand. But when undertaking so to do and before giving the result, he should request permission to correct the figures if upon checking them over at his leisure he finds any errors or matters that he desires to change. This creates a much better impression than to refuse to make any calculations whatever. The writer has seen an alert judge or opposing counsel make a calculation, and make it correctly, while an expert who had been asked to make a calculation on the stand was arguing about the great length of time it would take and the impossibility of making the calculation in court.

Some experts make a practice of destroying, or leaving at home, details of the specific calculations on which their opinions or valuations are based. This practice may sometimes shorten cross-examination, but it is very unfair to

the court, which is the party often most interested in knowing the manner by which the opinion was reached. The value of an opinion depends very largely on the foundation upon which it rests. An opinion that is deduced from stated facts by a logical process of reasoning or by definite mathematical calculation is entitled to more weight than a mere floating unattached hypothecation.

Knowledge of the Law

If underlying data are asked for and it appears that they have been purposely withheld or destroyed, a court is justified in giving the testimony based thereon scanty consideration. At the same time, an expert whose opinion is the result of previous experience in many similar cases cannot be expected to carry his entire professional history around in a brief case. An intelligent witness, as well as an intelligent judge, will determine readily what it is pertinent to produce in response to the cross-examining attorney's requests.

Experts as well as lay witnesses often find difficulty in distinguishing between direct and hearsay evidence. The opinions of an expert should be his own, but the facts may be derived from others. Thus an expert may take, and it is often his duty to take, account of facts which of themselves would be hearsay and incompetent.

Thus in valuing real estate it is proper for an expert to inquire diligently as to sales of similar and adjacent properties, the prices and attendant conditions, and to utilize this information in forming his opinion of value. Yet these prices and conditions are wholly incompetent as direct evidence of value of the property in question, although they may be brought into the record through cross-examination if the opposing counsel so elects, and accordingly the witness should be prepared to give them when called for.

Similarly, the witness may consult authorities as to general practice or as to historical conditions, and he may base his opinion thereon to some extent. Yet he must be sufficiently conversant with the subject to be able to form an opinion of real value, and it must be his own opinion that he gives—not that of some authority he has consulted.

In general, an expert cannot be permitted to bolster up his opinion by citing authorities on direct examination, but he may be asked on cross-examination to cite some authority for an opinion he has given. Authorities may be cited to the witness on cross-examination for the purpose of controverting the opinions he has given. In general, the witness will first be asked if he accepts the work of such or such an author as an authority on a certain subject. An expert may accept a certain authority as a whole or in part or on certain subjects and not on others. Few so-called authorities are wholly correct, and fewer still are wholly wrong.

Some knowledge of technical matters is admittedly of value to an attorney engaged in the trial of technical cases, and attorneys do not hesitate to utilize such knowledge in questioning witnesses. An engineer likewise may be better capable of assisting the court by virtue of the possession on his part of some knowledge of fundamental principles of the law underlying the subject in hand. This is especially true for example in land-title and boundary cases. The use of such knowledge in preparation of technical evidence or in formulating answers to questions on the witness stand does not necessarily involve the adoption of the rôle of advocate on the part of the expert nor the usurpation of the functions of the court.

It is a most common practice among attorneys on cross-examination to attempt to prove an expert witness inconsistent by producing his evidence in some other case and seeking to show that opinions he there presented controvert the ones he is giving. In such practice the opposing counsel as a rule carefully avoids giving the witness any opportunity to explain the differences in conditions in the two cases; and it may happen that there is not the slightest inconsistency in the testimony of the expert in the two cases, when the attendant conditions are considered.

In such an instance the expert must rely upon his counsel to secure an opportunity to make the necessary explanation or statement of the distinguishing factors in the two cases. In general, it does not appear that lawyers gain much by such practices unless the contradiction is clear and the conditions identical.

Language; Hesitation; Advisory Experts

Perhaps it is unnecessary to say that nothing can be more helpful to the expert on the witness stand than clarity of thought and the ability to use in a masterful manner the language in which he is speaking. The witness needs perspicuity as well as perspicacity. If anything, it is the most important of the two.

The witness may and should take the necessary time to think before he answers a question. On the other hand, for a witness to hesitate too long before answering often creates the impression that the witness is stalled or uncertain. If the witness is as thoroughly qualified as he should be, he does not need much time in which to formulate an answer to a clear and fair question; and again, if the question is not clear or fair, he does not need much time in which to state that fact to the court.

An engineering expert is often called upon to sit in with the attorneys during the trial of a case, to offer suggestions in technical matters generally and to assist in the cross-examination of opposing experts. Here, especially, some knowledge of the rules of evidence is of value. It will greatly aid the consulting expert in properly framing questions to be asked by counsel. It is highly important, especially where counsel is not fully conversant with the technical questions involved, that questions written out and handed to him for use in cross-examination should be competent, material and relevant, since a change in form may render the question ambiguous or even absurd.

Leading questions in general are permissible on cross-examination; and if the opinion offered by an opposing expert appears to be too restricted or too broad, the truth may often be arrived at on cross-examination by either extending the principle or else reversing the principle.

For example, in one action a so-called hydraulic expert testified that placing flashboards 10 in. high on a certain dam would raise the water level 3 ft. at a point 10 mi. upstream. The cross-examining attorney, wholly ignorant of hydraulics, doubted this evidence; he was by no means sure of its untruth, but he realized that if it was true it was fatal to his case. Therefore, it was important to controvert it. The result was readily accomplished by reversing and extending the principle. The river was 7 ft. deep and the dam was 8 ft. high. The witness was easily led into the admission that if his evidence was true, then lowering the dam 30 in. would dry up the river, an obvious absurdity.

Cincinnati Motor Racetrack

By George C. Mills*

The latest addition to the list of 2-mi. automobile racetracks is located near the north boundary of Hamilton County, Ohio, on the Dayton pike, about 14 mi. from Fountain Square, Cincinnati.

This is an oval track with tangents 1,826.35 ft. long and 180° curves of 3,415.65 ft. length; the tangents are parallel. The elements of the alignment are shown on the accompanying plan, Fig. 2. The curved portion of the track was developed from straight segments.

The track is 70 ft. wide. The flooring is 2x4-in. yellow pine, 14 ft. or over in length, dressed on one side and one edge, except where beveling is required owing to the curvature of the track. The flooring is laid loose on the track timbers with the exception of that portion forming the guard rail on the outside of the curve, which is spiked to the blocking. The first two strips on the inside of the track are also spiked together and to the bearing timbers.

The floor strips are laid with joints well broken; each strip is spiked to the adjoining strip with 20d. wire-cut nails, driven laterally, leaving ¼ in. at the head of each nail exposed to form spaces between the strips. These nails were driven 12 in. between centers and were staggered.

The sides of the flooring strips are beveled to maintain the spacing at the surface of the track when required by curvature of the cross-section. The curved cross-section of the track was developed from a true arc of a circle with timbers cut accordingly. The superelevation at the middle point of the turn is 26 ft.

A safety run of well-rolled earth encircles the field immediately inside the track. This is graded in cut or fill to the same level as the inside edge of the track, rising 6 in. toward the infield. The width varies from 10 ft. on the straightaways to 20 ft. on the curves, except in front of the grandstand, where concrete paving is provided to a width of 20 ft.

The topography made necessary a moderate amount of grading. The inner edges of the two stretches of straightaway rise uniformly from El. 593.0 at the P.C.'s on the west end to El. 596.0 at the P.C.'s on the east end. Beneath the track the ground is graded to leave a clearance of not less than 2 ft. from the top of the ground to the finished surface of the wood flooring; and where the ground outside of the track is higher than the track, a terrace is formed and a drainage ditch excavated.

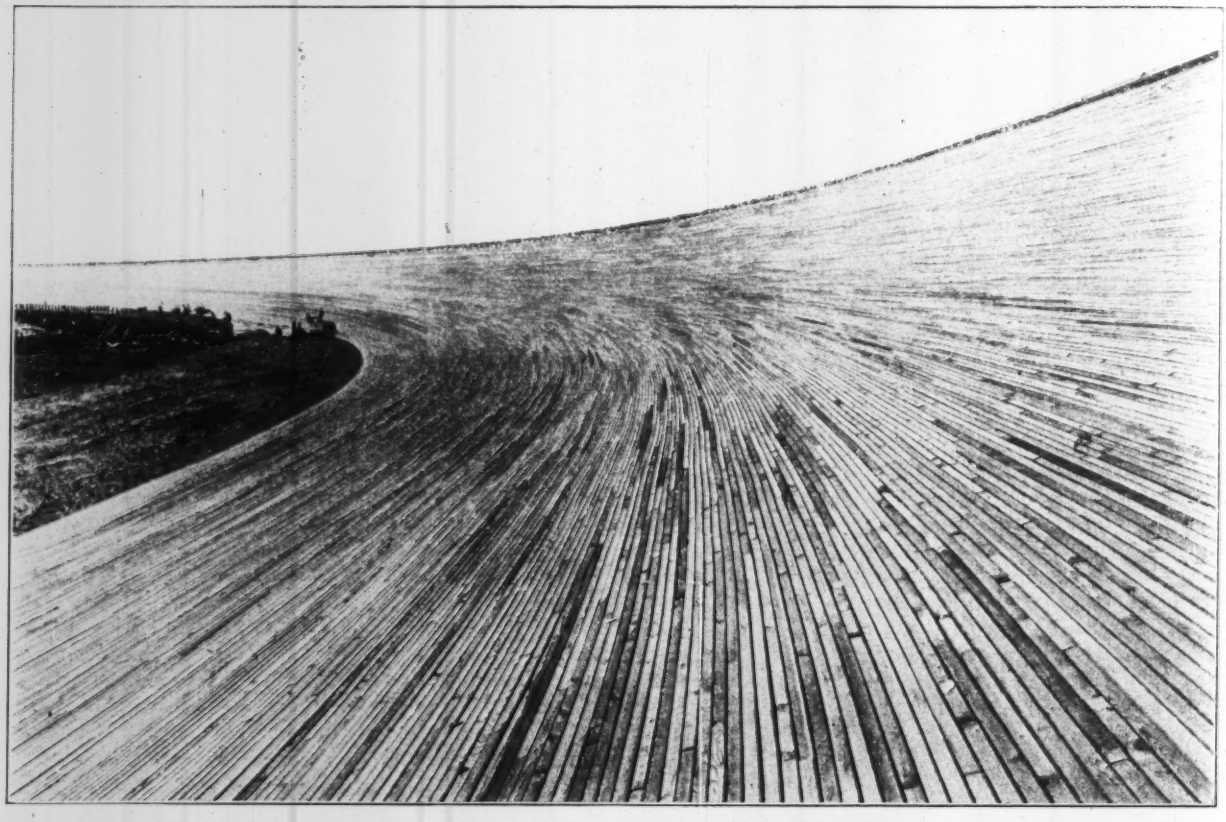

FIG. 1. VIEW ON A BANK OF TWO-MILE MOTOR RACETRACK AT CINCINNATI, OHIO

A concrete tunnel under the track opposite the entrance to the park provides access to the parking spaces on the infield. All piers and footings for the stands and track, the repair pits opposite the grandstand and the paving of the safety run opposite the grandstand are also of concrete. The track is inclosed by wire fencing, 8 ft. high, of Nimmo design, excepting where the superelevation at the outside of the curves renders fencing unnecessary.

The grandstand and bleachers have each a seating capacity of 15,000. About 4,000,000 ft. b.m. of lumber was used in the construction of stands and fence around

*Civil Engineer, Cincinnati, Ohio.

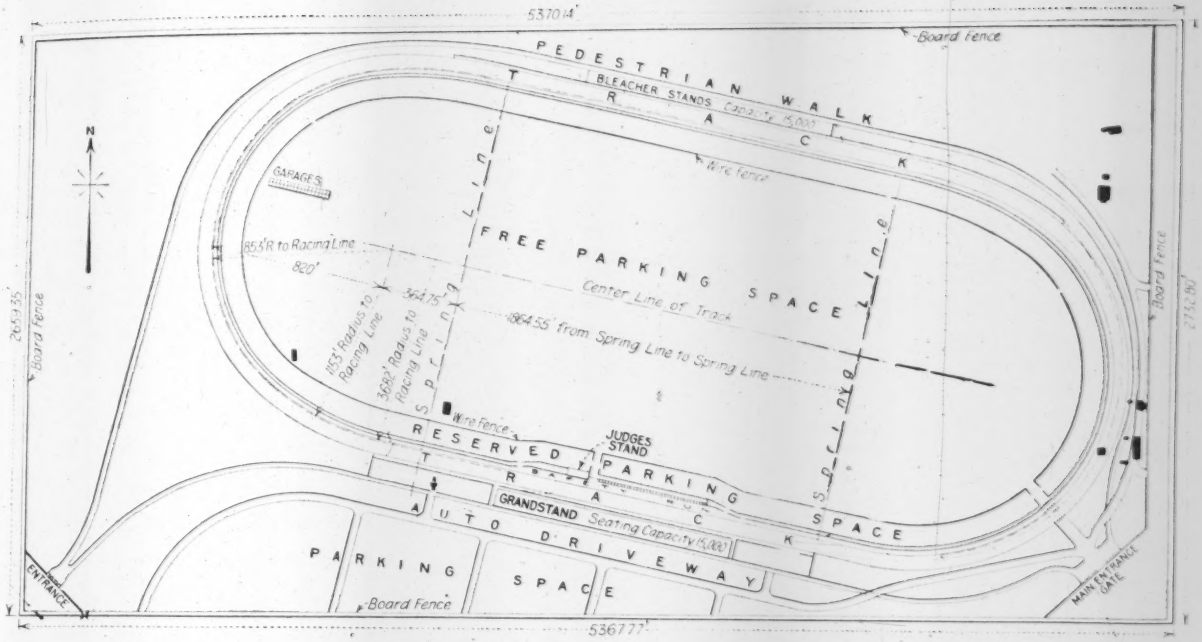

FIG. 2. PLAN OF CINCINNATI MOTOR RACETRACK, SHOWING ELEMENTS OF ALIGNMENT

the park, with some interior fencing and small structures, and an equal amount of lumber was required for the track itself.

Work was begun May 1 and was completed Aug. 31 of last year. The total cost, including land, was $550,000. The track was opened on Sept. 4 with a 300-mi. race. There were about 30 contestants, and an average speed of 97 mi. per hr. was made.

The architect was Harry Hake, of Cincinnati, and the contractors were A. Ryan & Co., of Springfield, Ill.

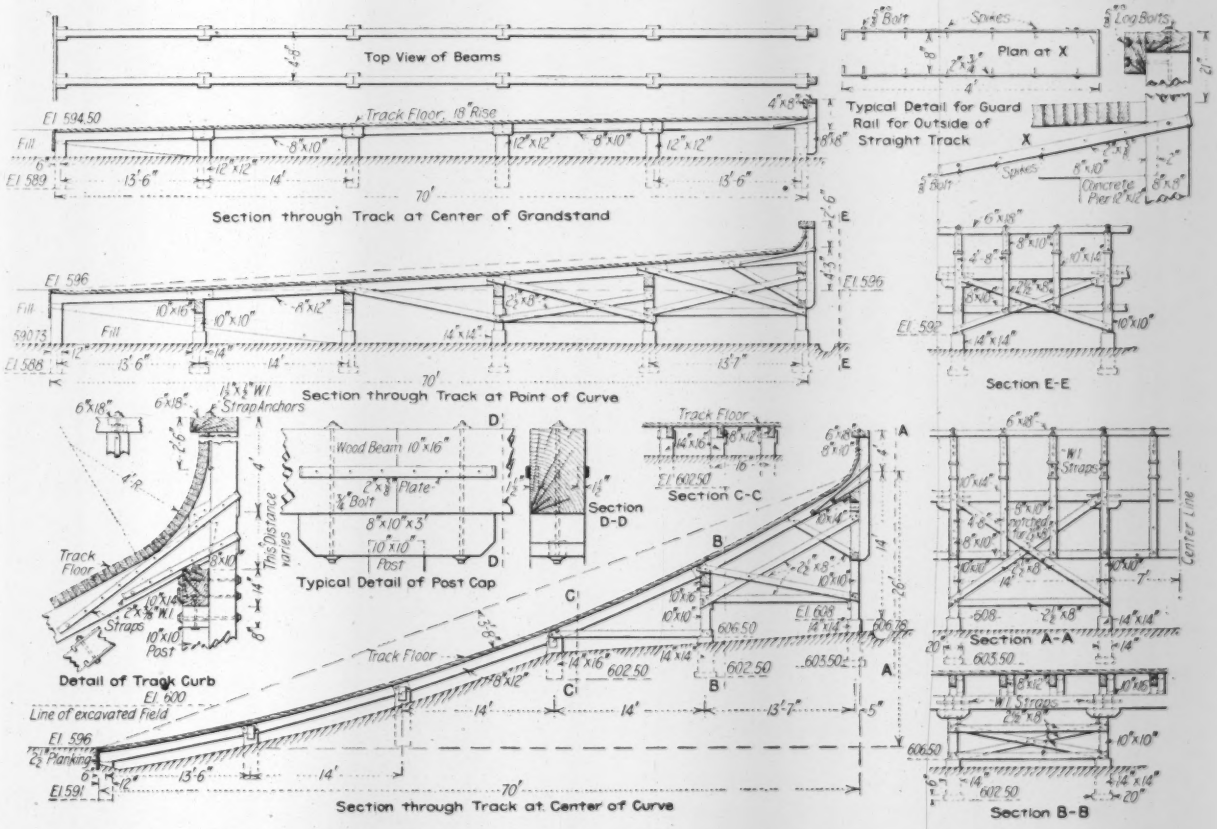
Top View of Beams
Track Floor, 18" Rise
Section through Track at Center of Grandstand
Plan at X
Typical Detail for Guard Rail for Outside of Straight Track
Section through Track at Point of Curve
Section E-E
Wood Beam 10"x16"
Typical Detail of Post Cap
Section D-D
Section C-C
Detail of Track Curb
Section A-A
Section B-B
Section through Track at Center of Curve
Line of excavated Field
Center Line

FIG. 3. TYPICAL CROSS-SECTIONS OF CINCINNATI MOTOR RACETRACK AND CONSTRUCTION DETAILS

Formulas for the Three-Piece Frame and Eccentrically Loaded Columns

By Alfredo C. Janni*

There are two ways of finding formulas for the stresses in a rigid frame of four or three members—namely, by the law of virtual works and by the theory of the ellipse of elasticity. In the opinion of the writer the second way is by far the shorter and the more elegant. For the present purpose, however, only the resulting formulas will be given, without going into the method of derivation.

The reader who wishes to familiarize himself with the theory of the ellipse of elasticity is referred to "Reinforced-Concrete Construction," by Prof. G. A. Hool, Vol. III, Chap. VIII, in which is shown a purely graphical method of designing arches derived from this theory.

Fig. 1 represents a three-member frame comprising a girder supported at its ends A and B by posts CA and DB, the girder connections at A and B being rigid and the two posts rigidly fixed at their bases C and D. By the theory of the ellipse of elasticity, if G is the elastic weight of the whole system $CADB$, its value is given by

$$G = \frac{l}{EI} + 2\frac{h}{E_1 I_1} \qquad (1)$$

where

E = Modulus of elasticity of the material of the girder;

E_1 = Modulus of elasticity of the material of the columns;

I = Moment of inertia of the girder cross-section;

I_1 = Moment of inertia of the column cross-section.

If for simplicity we put

$$\beta = \frac{h}{l} \times \frac{EI}{E_1 I_1}$$

then the expression (1) may be written

$$G = \frac{l}{EI}(1 + 2\beta) \qquad (2)$$

The vertical distance of the elastic center from the line AB will be given by

$$d = \frac{2\frac{h}{E_1 I_1} \times \frac{h}{2}}{\frac{l}{EI} + 2\frac{h}{E_1 I_1}} = \frac{h\beta}{1 + 2\beta} \qquad (3)$$

Since $\frac{l}{EI}$ is the elastic weight of the girder AB and $\frac{h}{E_1 I_1}$ is the elastic weight of one column, the moments of inertia of the entire elastic system with respect to the axes X and Y passing through the center of gravity of the elastic system will be given by

$$I_x = 2\tfrac{1}{3} \times \frac{h^3}{E_1 I_1} - Gd^2 = 2\tfrac{1}{3} \times \frac{h^3}{E_1 I_1} - \frac{l}{EI}(1 + 2\beta)d^2 \qquad (4)$$

$$I_y = \frac{l^3}{12EI} + 2\frac{h}{E_1 I_1} \times \frac{l^2}{4} \qquad (5)$$

The values (2), (3), (4) and (5) are the base upon which formulas for various cases of loading can be worked out, as will be shown presently.

Case 1. Concentrated Load—If we imagine that the end C is free, the elastic displacement of C under action of the load F, Fig. 2, may be considered as composed of a rotation and vertical and horizontal displacements. If furthermore, we imagine that the elastic center G is rigidly connected with C, then its displacement will be the same as that of C; that is, it will have the same rotation and the same linear displacements, vertical and horizontal.

In order to bring G to its former position, we must apply at C a force capable of impressing upon G a rotation, a vertical displacement and a horizontal one equal and of contrary sign to those performed by G under the action of force F. This force (or group of forces) is the actual reaction at C.

Calling M, V and H the moment (with respect to center G), vertical component and horizontal component of this reaction, by the theory of the ellipse of elasticity we may write

$$MG = F\left(\frac{h}{E_1 I_1} d_2 + \frac{d_2}{EI} \times \frac{d_2}{2}\right) \qquad (6)$$

$$VI_y = F\left[\frac{h}{E_1 I_1} \times \frac{l}{2} d_2 + \frac{d_2}{EI} \times \frac{d_2}{2}\left(\frac{l}{2} - \frac{1}{3} d_2\right)\right] \qquad (7)$$

$$HI_x = F\left[\frac{h}{E_1 I_1} d_2\left(\frac{h}{2} - d\right) - \frac{d_2}{EI} d \frac{d_2}{2}\right] \qquad (8)$$

where the first members represent the rotation, the vertical displacement and the horizontal displacement of the point G under the action of the reaction R, while the second members represent the same displacements of G under the action, however, of the force F.

Formulas (6), (7) and (8), with the values given by formulas (2), (4) and (5), will become

$$M = F\frac{d_2}{2} \cdot \frac{\frac{d_2}{l} + 2\beta}{1 + 2\beta} \qquad (9)$$

$$V = F\frac{d_2}{l} \times \frac{6\beta + 3\frac{d_2}{l} - 2\left(\frac{d_2}{l}\right)^2}{1 + 6\beta} \qquad (10)$$

$$H = \frac{3}{2} F \frac{d_1 \times d_2}{lh(\beta + 2)} \qquad (11)$$

Incidentally it is seen by inspection of formula (11) that the horizontal thrust H varies according to the ordinates of a parabola.

Assuming that AB is a 20-ft. beam loaded with 2000 lb. at F, Fig. 2; $h = 15$ ft., $d_2 = 12$ ft. And assuming, for the sake of simplicity, that $\beta = \frac{h}{l} \times \frac{EI}{E_1 I_1} = \frac{15}{20}$, that is $E_1 = E$, and $I_1 = I$, we will have $M = 10{,}080$ ft.-lb., $V = 12{,}120$ lb., $H = 349$ lb. Therefore, the coördinates of the reaction R will be given by $x = \frac{M}{V} = 0.83$ ft., $y = \frac{M}{H} = 28.84$ ft.

Once the reaction is known, the stresses in any section of the column can be easily computed.

The position and intensity of the left reaction R being determined, it is an easy matter to determine the right reaction, remembering that the acting external force and the two reactions, must meet at the same point. This remark, of course, holds good for each of the following case also.

Case 2. Uniform Load—If we call w the uniformly distributed load on the girder, then from formulas (9), (10) and (11), after simplifications, we obtain

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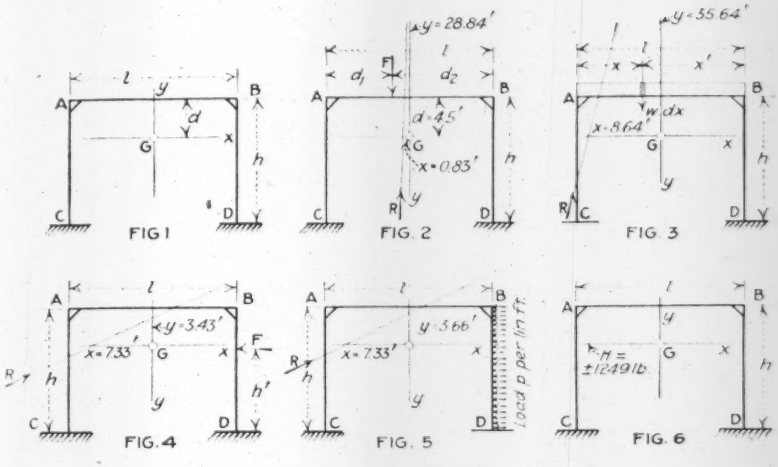
$$M = \frac{wl^2}{2} \times \frac{\frac{1}{3} + \zeta}{1 + 2\zeta} \qquad (12)$$

$$V = \frac{wl}{2} \qquad (13)$$

$$H = \frac{1}{4} \times \frac{wl^2}{h(2 + \zeta)} \qquad (14)$$

For the same dimensions as in the preceding case, and again making $E_1 = E$, $I_1 = I$, the reactions for a load $w = 2000$ lb. per lin.ft. will be $M = 172{,}800$ ft.-lb., $V = 20{,}000$ lb., $H = 4848$ lb. Therefore the coordinates of the reaction R, with respect to the axes Gx and Gy, will be $x = 8.64$ ft., $y = 35.64$ ft.



STRESSES IN THREE-MEMBER FRAMES

Case 3. Horizontal Load—By considerations similar to those made in Case 1 and observing that, if the end C (Fig. 4) be assumed as free, its displacement is the result of the deformation of the system from D to F, since the force F has influence only on this part of the system, we obtain

$$MG = F\frac{h'^2}{2E_1 I_1} \qquad (15)$$

$$VI_y = F\frac{h'}{E_1 I_1} \times \frac{l}{2} \times \frac{h'}{2} \qquad (16)$$

$$HI_x = F\frac{h'}{E_1 I_1} \times \frac{h'}{2}(h - d - \tfrac{1}{3}h') \qquad (17)$$

Substituting for G, I_y and I_x their values given by (2), (4) and (5), we have

$$M = \frac{F}{2} \times \frac{h'^2}{h} \times \frac{\zeta}{1 + 2\zeta} \qquad (18)$$

$$V = 3F\frac{h'^2}{hl} \times \frac{\zeta}{1 + 6\zeta} \qquad (19)$$

$$H = \frac{3}{2}F\left(\frac{h'}{h}\right)^2 \frac{1 + \zeta - \frac{1}{3}(1 + 2\zeta)\frac{h'}{h}}{2 + \zeta} \qquad (20)$$

With the same dimensions as before, and putting $F = 5000$ lb. and $h' = 10$ ft., the formulas give $M = 5000$ ft.-lb., $V = 681.8$ lb., $H = 1454.5$ lb. Therefore we derive $x = 7.33$ ft., $y = 3.43$ ft.

Case 4. Uniform Horizontal Load—Fig. 5 sketches the conditions. The following formulas may be derived from those for Case 3:

$$M = \frac{\zeta ph^2}{6(1 + 2\zeta)} \qquad (21)$$

$$V = \frac{\zeta ph^2}{l(1 + 6\zeta)} \qquad (22)$$

$$H = \frac{ph}{8} \times \frac{2\zeta + 3}{\zeta + 2} \qquad (23)$$

With the same dimensions as before, and with load $p = 1000$ lb. per lin.ft., these formulas give $M = 1125$ ft.-lb., $V = 153.4$ lb., $H = 306.8$ lb. The coordinates of the reaction R will be $x = 7.33$ ft., $y = 3.66$ ft.

Case 5. Variation of Temperature—If we still imagine that the end C of the elastic system is free to displace and that the temperature of the whole system changes t degrees, the shape of the system remains similar to its original shape, but a unit length will become $1 + at$, where a is the coefficient of linear expansion of the material. (Fig. 6).

The beam AB, will assume the length $l(1 + at)$, and the end A of it will displace itself in the direction BA of the amount lat, without rotating. The reaction R, acting on A, in order to push back A to its former place must pass through the elastic center G and must be horizontal. Therefore we may write

$$HI_x = atl \qquad (24)$$

which with (4) becomes

$$H = \frac{3EIat(1 + 2\zeta)}{h^2\zeta(\zeta + 2)} \qquad (25)$$

Assuming $t = 40°$ F. as the change of temperature in the whole system, and $I_1 = I = 1$, $a = 0.0000067$, we have $H = \pm 1249$ lb.

In a similar way formulas for other assumptions of loading could be worked out.

Test Piles for Foundations—Preliminary to the design of the foundation of the new packing plant for Armour & Co., at South St. Paul, Minn., test piles were driven to determine the character of the soil and the pile-driving conditions, etc. Wood and concrete piles of different lengths were included. These were not for loading tests, and none of the piles were loaded. It was understood from the local authorities that rock would be struck at a depth of 24 to 28 ft., and a number of piles were driven at different parts of the site for the purpose of ascertaining ground resistance under the hammer, and also to see whether rock could be found. Although piles were driven to a depth of 60 ft., they did not reach any rock; hence the only result obtained from this test was that it indicated the resistance under the hammer. It was found that at a depth of about 20 ft. the penetration was about ½ in. per blow from a 5,300-lb. steam hammer of 30-in. stroke. At 26 ft. it seemed to run pretty regular in all piles, the penetration amounting to about ¼ in. and diminishing to about ⅛ in. at the last blow. It developed that with a wood pile driven down 50 ft. about the same penetration per blow was obtained as with a concrete pile at 26 ft. In view of these conditions it was decided to use wood piles. In determining the foundation piling for the proposed plant, the designers will take into consideration the ground resistance shown under the hammer and the desired load limit. The test piles were driven by Grant Smith & Co., of St. Paul, under the direction of R. C. Clark, of Chicago, architect for Armour & Co.

Slide Gates and Needle Valves in the Elephant Butte Dam

By F. Teichman*

In *Engineering News*, Nov. 30, 1916, p. 1015, the writer described in a general way the outlet control system of Elephant Butte Dam; below is given a short description of the two styles of gates employed in that control, the rectangular slide gates (3 ft. 11 in. by 5 ft. and 3 ft. 11 in. by 7 ft. 6 in.) and the balanced needle valves for 5-ft. diameter pipe.

Fig. 1 shows the 3-ft. 11-in. by 5-ft. slide gates. The upstream edges of the ribs of the gate leaf are connected by a faceplate, thus precluding the possibility of any drift being caught between the ribs and the roof casting. This faceplate has open cored holes (1⅝ in.) which in the process of molding were required to support the cores between ribs. The spaces that were occupied by the cores, at the lower end of the gate, are filled with concrete or hard-grade asphalt, which will prevent deterioration of the inner surfaces and adds mass to the gate. On account of this filling and of the use of both downstream and upstream faceplates on the gate leaf the tendency of the lower end of the gate to objectionable elastic vibrations, while the gate is partly open, is greatly diminished. The gate is laid out with small clearance, ⅛ in. for the upstream plate and $\frac{1}{16}$-in. clearance in the guide grooves.

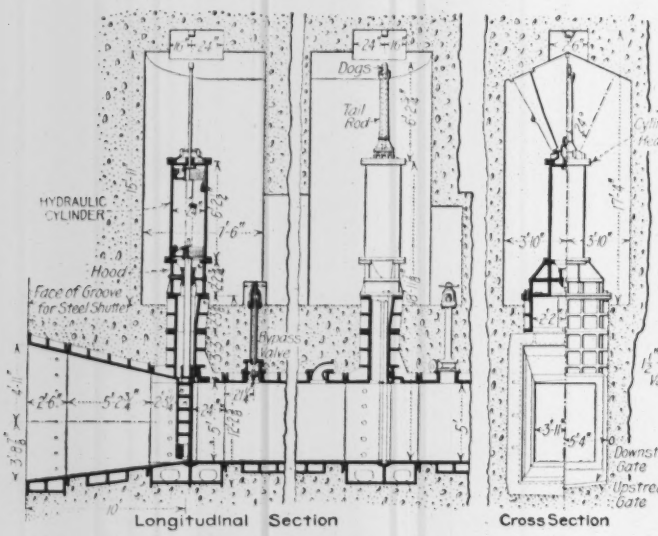


FIG. 1. THE ELEPHANT BUTTE DAM SLIDE GATES

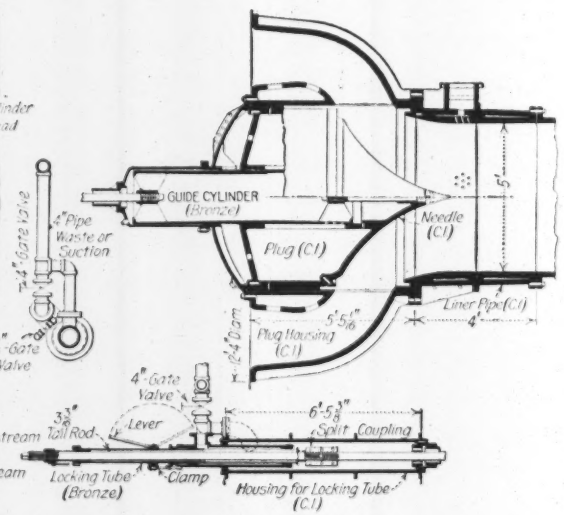


FIG. 2. THE ELEPHANT BUTTE DAM NEEDLE VALVES

Details of the Slide Gates

The lower end of the gate makes closure not by overlapping the frame, but by contact of the finished end face of the gate leaf with a bar of babbitt cast and hammered into a taper groove of the floor casting and finished to a true face. Such a form of "end closure" has been used with success heretofore by the Reclamation Service for large gates under high heads.

The gate leaf is cored for its whole length for two gate stems, 15 in. c. to c., which connect at their upper end with a crosshead, threaded for the central piston rod of the hydraulic cylinder. This arrangement double through gate stems, compared with the usual c tral gate stem of partial penetration of gate leaf, h several advantages: It is easy thus to avoid a weakeni of the gate leaf in the plane of the gate stems witho increase of maximum thickness of gate body; any te sion in the downstream faceplate of the gate (in the pla of the upper face of the nut of the central gate stem which may be dangerous when opening a large gat closed and under high head, is avoided; the axis of th piston rod is nearer the plane of the faceplate than is possible for a single gate-stem arrangement.

The gate leaf and the frame have bronze liners on thre sides, the compositions being respectively: Copper, 82.7 tin, 7.1; zinc, 5.3; lead, 4.9; and copper 82.8; tin, 4.8 zinc, 4.4; lead, 8. These alloys originated with the James Jones Co. Brass Works, of Los Angeles. They are dense and hard castings that will slide on each other under heavy unit load without seizing. These liners are held in place by ½-in. rivets of Delta metal, heads being formed hot. This metal gave more assurance against a breakin under the head than any other bronze that was tried.

The crosshead of the gate stems and piston rod, which is cast in manganese bronze and has slight clearance between the nuts of the gate stems and the gate leaf, has slightly more clearance around the gate stems than the gate leaf has in its guides, so that the gate leaf may move as far as the clearance in the guide grooves will permit without exerting any side pressure on the piston rod.

The side guides and the liner above the gate opening are so arranged that they can be taken out and replaced if, during the long life that is expected of the structure as a whole, they should deteriorate to an extent to make such replacing necessary.

There is only a single stuffing-box arranged between the hydraulic cylinder and the space wherein the gate leaf moves, and this stuffing-box can receive attention only after first raising the hydraulic cylinder. This may appear as an objection, but after the following description this objection will lose significance. Speaking, as an illustration, of the six penstock gates (3 ft. 11 in. by 5 ft.), which will always be either wide open or fully

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closed, their piping will be so arranged that they may individually be closed from the power house or any convenient place by simply turning a cock—a desirable convenience in case of accident to any machinery in the power house. This is accomplished by leading an individual pressure pipe from the power house to each hydraulic cylinder, with branches to both ends of the cylinder.

The discharge pipes from both ends of the cylinder lead into the gate housing—that is, to the reservoir water upstream from tthe gate. When the gate is open, the weight of the gate, etc., rests on two dogs fitted against the lower face of a collar screwed to the upper end of the tail rod. The dogs are connected by toothed quadrants and weighted. When the above-mentioned cock is opened, the pressure water enters under the piston and raises it about ⅜ in. (to the end of its stroke), the dogs are freed by the raising of the collar, they drop over and reverse the valves (or fourway cock) of the hydraulic cylinder, and the gate moves down to closure.

It will be seen that with closed cock and gate, either up or down, there is no leakage around the stuffing-box or the piston, the pressure everywhere being that of the reservoir. Under these conditions, where the stuffing-box is "working" only during the short periods when the gate is being raised or lowered, no deterioration of the packing of the stuffing-box need be anticipated, and it will be many years before it will become necessary to raise the cylinder in order to make the stuffing-box accessible. In the meantime the stuffing-box, being hidden, cannot occasion annoyance.

In all upstream gates the process of packing the stuffing-box is facilitated by a relief port and plug at half-height of the liner just below the stuffing-box.

By having the reservoir pressure as back pressure the working pressure must be so much greater. But at those times when the greatest effective pressure on the piston is required (when starting to open the closed gate) the back pressure may be reduced to atmospheric pressure.

To reduce as much as possible all danger of breakage of parts, cast-iron roof struts are provided with removable steel bar of slight taper, fitting between the lower end of the strut and a groove in the cylinder head. The structure is designed to be strong enough under maximum load (when the gate is being closed under maximum head) without the aid of the roof struts. But the device is simple and cheap and will gain in appreciation as the deterioration of the parts progresses.

Details of Balanced Needle Valve

The balanced needle valve is shown in Fig. 2. The body of the needle has at its upstream end an enlargement—the bullring—which works with slight clearance in the cylinder that surrounds it. The moving needle is subjected in any position to the following axial forces: (1) Gravity, if the axis of the needle is inclined; (2) friction; (3) pressure of the water in the chamber upstream of the needle; (4) pressure on the downstream face of the bullring; (5) pressure of reaction on the downstream face of the needle; (6) negative pressure on the downstream face of the jet, obtaining when the jet produces a partial vacuum in the space just below the needle. Force (3) is downstream, but will be upstream when suction obtains in the chamber. Force (5) is absent when the needle is closed.

The chamber has an outlet that controls the movement of the needle. With the outlet closed the needle will close by the action of the water that enters the chamber as leakage around the bullring. With the outlet sufficiently open the needle will open, the forces (4) and (5) predominating. For any given reservoir head and position of needle, there is a certain opening of outlet for which the needle will be held stationary in its position. With the needle closed and the chamber outlet closed there is no leakage around the bullring; likewise with the needle wide open and the outlet open there is no leakage, due to the bullring being up against an annular seat face inside the head of the chamber. For low reservoir head and closed gate (where force (1) is small and force (5) is absent), likewise for low reservoir head and small needle openings (where force (5) is small), especially if the axis of the needle is inclined—that is, force (1) is directed downstream—it will require a suction head in the chamber to open the gate or to hold it in open position—unless the bullring should have been made of large radial width.

In the accompanying figure the water leaving the chamber first enters the needle casting, then passes through the guide cylinder and the sleeve into the housing of the locking tube; then it passes out through the 4-in. gate valve, if this is open; or if this is not open and the locking disk stands at a distance from the end of the locking tube, it passes out through the locking tube and 3½-in. piping. The 4-in. piping can at will be connected to a draft tube. Ordinarily, the locking tube is pressed against the locking disk by the action of a spring at the end of the tail rod. If for any position of needle the locking tube is clamped by the mechanism provided therefor, and if the 4-in. gate valve is closed, the needle together with the locking disk will move downstream by the action of the leakage water passing the bullring until the distance between the end of the locking tube and the locking disk (less than one inch) is such that the resulting pressure on the upstream face of the needle balances all other axial forces on the needle, and there the needle will remain.

How To Operate the Needle Valve

These, then, are the simple rules for the operation of the needle valve: For opening the needle valve, open the 4-in. gate valve; for closing the needle valve, close the 4-in. gate valve; for holding the needle valve in any desired position, clamp the locking tube when the needle valve has attained that position. The rate of closing the needle depends on the rate of leakage around the bullring, and this may be smaller than is desired. For such case a 1½-in. bypass pipe is provided.

As the leakage water passes the bullring and enters the chamber of low pressure, air and carbon dioxide are liberated and will collect in the upper part of the chamber. These gases can easily be eliminated if the water in the chamber is under pressure, but not so easily if the chamber has the negative pressure of partial vacuum. Their presence—and therefore the partial vacuum—is objectionable because under such circumstances the needle may perform its opening or closing motion not evenly, but spasmodically, and such spasmodic motion may be harmful if occurring at either end of the stroke of the needle. It will be noticed that no damage can be done to the locking mechanism; the locking tube will merely slip

in the clamp in case of a lunging of the needle. No harm due to the lunging of the needle has yet been suffered by any of the needle valves of the Reclamation Service.

The Elephant Butte needle valve is a modification of the Ensign needle valve first designed by O. H. Ensign, of Los Angeles, for the Roosevelt Dam. That valve differs from the one here described in the following particulars: It has no tail rod; it has two V-shaped guides (instead of the six flat guides); it has a larger bullring (however, it still makes use of the vacuum), and the mechanism of control is different. It uses—in the later designs—the same principle of control tube (first suggested by the writer), but the control tube is not central and is moved upstream or downstream—the needle following—by means of screw and gearing.

The water for the operation of the hydraulic cylinders of the slide gates is furnished by a triplex 3x8-in. single-acting plunger pump driven by motor and installed in the small hydro-electric plant located at the toe of the dam. This pump can furnish 30 gal. per min. at 1000 lb. per sq.in. This is equivalent to a travel of the piston of 15 in. per min. in a 24-in. diameter hydraulic cylinder. Relief valves are arranged by which the maximum pressure can be defined. Single straightway valves regulate the inlet and outlet of the cylinders.

All operating galleries and chambers are well lighted and ventilated.

The different gate devices herewith described were designed by the writer and installed by E. H. Baldwin, Construction Engineer, and his successor, L. J. Charles.

The sluice and penstock gates (790,000 lb.) were furnished by the Hinman Hydraulic Manufacturing Co. (now the Vulcan Iron Works), of Denver, Colo. The machine work was excellent and the quality of castings good. The transition castings of the six penstock conduits (rectangular section of conduit going over into round section), followed by 10 ft. of straight 5-ft. diameter pipe (total 222,600 lb.) were furnished by the Eddy Foundry Co., of Milwaukee, Wis. The 3-ft. 11-in. by 7-ft. 6-in. slide gates (422,000 lb.) were furnished by the Coffin Valve Co., of Neponset, Mass. The machine work was of a high order. The four balanced valves (364,000 lb.) were furnished by the Best Manufacturing Co. (now Kennedy-Stroh Corporation), of Pittsburgh, Penn. The machine work and the quality of the castings were very satisfactory. The cost of all this machinery was about $147,000. The total cost of the gates in place, with all auxiliaries, is approximately $221,000.

Design and Construction of Double Sewer at Jamestown, N. D.

Changes and extensions of the sewerage system of Jamestown, N. D., have required the construction of about 8000 ft. of double sewer, designed to provide for the complete separation of sewage and storm water. The sewage is carried in a vitrified pipe placed in the bottom of the trench, and the storm water in a separate horseshoe-shaped monolithic concrete section placed directly above the sanitary section, as shown in Fig. 1.

FIG. 5. VIEW OF EXCAVATOR AT WORK ON DOUBLE SEWER AT JAMESTOWN, N. Y.

Alternate bids were received for double sewers, using the type of construction shown in Fig. 2, the storm-water section to consist either of segmental sewer blocks or of reinforced-concrete pipe supported on a lean concrete saddle. The lowest bid for the type of construction shown in Fig. 2, based on segmental sewer blocks, was $4200 above the contract price for the type of construction shown in Fig. 1, and the lowest bid based on using reinforced-concrete pipe was $10,000 above.

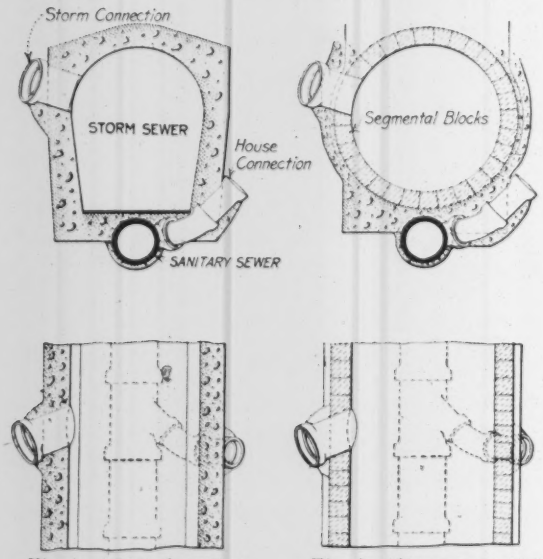


Fig. 1. Adopted section

Fig. 2. Alternate section

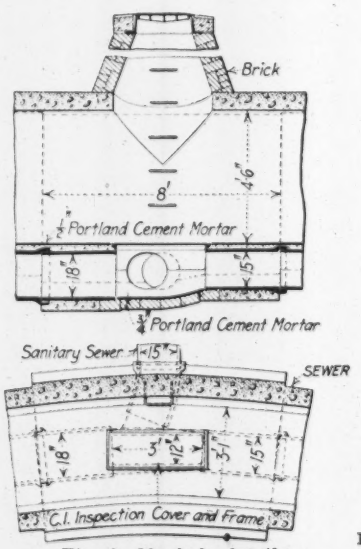


Fig. 3. Manhole details

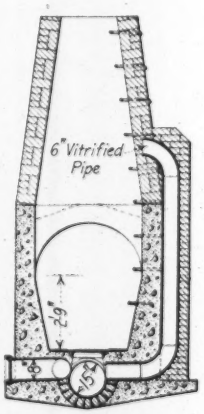


Fig. 4. Vent on sanitary sewer

FIGS. 1 TO 4. DETAILS OF STORM AND SANITARY SEWERS, JAMESTOWN, N. D.

The size of the sanitary section will vary from 12 to 18 in. in diameter and the size of the storm-water section from 32x41 in. (equivalent to 36 in. circular) to 44x54 in. (equivalent to 48 in. circular).

The type of construction shown in Fig 1 will be used throughout, with the exception of a short distance near the outlet, where the storm-water section will be carried direct to the river and the sanitary section will be carried a few hundred feet to the east to the site of the sewage-treatment plant. Fig. 1 also shows the manner in which the house connections will be made to the sanitary section and the storm-water connections to the storm-water section.

Manholes of special design will be used, as shown by Figs. 3 and 4, Fig. 3 being the manhole where a 15-in. intercepting sewer connects to the trunk sewer and Fig. 4 showing how the connection between different sizes is made. Vents, as shown in Fig. 4, will be provided at a number of manholes along the line of the sewer to furnish ventilation for the sanitary section until such time as a sufficient number of house connections have been made.

At each manhole and at several points between manholes, where the manholes are at some distance apart, inspection covers and frames will be provided at the bottom of the storm-water section for the purpose of giving access to the sanitary section for inspection and cleaning.

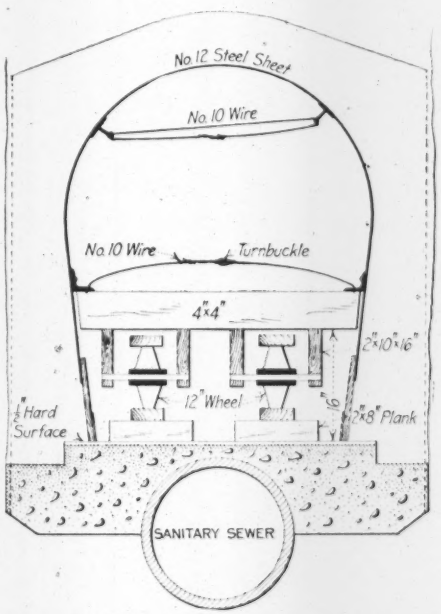


FIG. 6. FORM USED FOR JAMESTOWN DOUBLE SEWER

The trenching is done with a W. G. Humphrey excavator (Fig. 5). The material is shale with some sand and gravel. As the trench is cut with the machine, the base for the vitrified pipe is shaped and the material cast into the excavator by hand. The pipe is then laid and backfilled to the half-section, and the concrete base is poured and finished with a ½-in. hard surface. From 170 to 240 ft. of pipe and base is put in each day.

The forms used for the side walls and arch consist of No. 12 sheet steel, in 60x120-in. sheets, bent to correct lines and held to form by wiring (Fig. 6), fastened to small tee and angle irons riveted to the inside of the sheets. The forms are supported by 4x4-in. timbers, spaced 4 ft. apart under the lower angle irons and carried on the frames of a series of four-wheeled cars. The trains are made up of two strings, one 120 ft. long and one 130 ft. long, a train of forms being removed each alternate day. The forms are brought to position by wedges and shims between the car frame and the concrete base, the entire weight thus being taken off the car wheels. A 10-in. board is used on each side to complete the form for the side wall and allow for raising and lowering.

The concrete mixer works on the surface, the concrete being distributed in two-wheeled carts and carried into the trench for both base and side walls by means of troughs.

The double sewer is about completed and the construction of treatment works started. These will include an Imhoff tank of reinforced concrete, with 2½-in. rib-lath plastered curtain walls, work on which will be begun in February, sludge-drying beds, and a short outlet from the tank to the James River. The double sewer and treatment works were designed by L. P. Wolff, consulting engineer, St. Paul, Minn., and are being carried out in direct charge of J. M. Hansen, city engineer. The contractor is William Danforth, St. Paul, Minn.

War Department Forming Engineer Enlisted Reserve Corps

The members of the Engineer Officers Reserve Corps, United States Army, have been notified by the War Department that a large enrollment is desired of enlisted men in the Engineer Enlisted Reserve Corps, provided for in the National Defense Act of June 3, 1916. All the equipment, subsistence and transportation are furnished by the Government, during service. An annual training period of 15 days is required. Pay ranges from $75 to $15 per month. The following requirements are stated for the several grades in the pioneer regiments:

Master Engineer, Senior Grade—Required at times to take the place of officers and to take independent charge of construction in the field; must be specially qualified also as expert lithographer, photographer, draftsman, surveyor or construction superintendent. Two to each regiment.

Master Engineer, Junior Grade—Same qualifications as for master engineer, senior grade; must be specially qualified as foreman electrician and expert searchlight operator, foreman carpenter, construction foreman or foreman machinist and engineman. Three to each battalion.

Other Grades Above Sergeant—Grades include sergeant major, sergeant first class, and supply, color, bugler, first and stable sergeants. Same qualifications required as for sergeant; must be specially qualified as master carpenter, master mechanic, road foreman, expert in demolitions, blacksmith, rigger, boatman, topographer or draftsman. Seven per company.

Sergeant and Lower Grades—Qualifications ascertained by recruiting or recommending officer. Every enlisted man out of the 109 in a pioneer company must have some special qualification, distributed (two to four each) among the occupations already noted and also among quarrymen, miners, plumbers, firemen, masons, calkers, axmen, packers, teamsters, saddlers, cooks, clerks, musicians and signalmen, the greatest preponderance being of topographical surveyors and sketchers (9), quarrymen and miners (11), bridge carpenters (16), electricians (6), axmen (8), teamsters (10). Six sergeants and 12 corporals per company.

Metering Fire-Protection Sprinkler Systems at Pittsburgh, Penn., will not be required, the council having passed over the veto of Mayor Joseph G. Armstrong an ordinance designed to relieve owners of such systems from setting meters.

Makawao Water-Works for Rural Supply

By Joel B. Cox*

SYNOPSIS—County water-supply for rural district, maintained under tropical conditions.

The Makawao water-works, in the County of Maui, Hawaii, are unusual in two respects—the very scattered consumers with comparatively great length of distributing mains, and the extreme difference of elevation (4200 ft.) between intake and lowest consumer. The maintenance problems of a wood-stave pipe in a tropical jungle are also of interest. The works were built with territorial funds under territorial supervision, but are operated by the county.

The water-works are situated on the slopes of Haleakala, an extinct volcano with a height of 10,032 ft. They supply water to 35 sq.mi. of farming and stock country, where without it there could be no settlement, as the rainfall is too infrequent and uncertain to provide drinking water, and there are no underground or surface supplies.

The highest intake is in Puohakamoa gulch, which contains a small but very constant stream, deep in the jungle on the eroded northeast slope of the mountain. This water is carried to Waiakamoe gulch, a distance of 1.5 mi. Waiakamoe is larger, but is not so steady a stream. In extremely dry periods it falls to a mere trickle. Here is a small reservoir behind a timber overfall dam. There are many smaller intakes in the intermediate gulches. The water is highly colored and has a characteristic taste of wood and other vegetable matter, as is the case with nearly all the jungle streams, but is otherwise of excellent quality.

From Waiakamoe a 12-in. wood-stave pipe 3.64 mi. long worms its way out of the forest to the open lands at Olinda, where the storage reservoir of the line is now being built. Here the largest branch leaves the main line and plunges straight down the mountain to Makawao and Paia, a 4100-ft. fall in 12.28 mi. The main line continues over a rapidly drying but very fertile slope, unwooded but seamed by sudden deep gulches, to the picturesque hills of the southwest corner of the island. The grade is from 1.5 to 3%.

Beyond the tenth mile from Olinda the country is used as a stock range, and the water is carried to the watering troughs of the stock ranches. Even beyond the end of the county line at Auahi, which is 22.4 mi. from the waterhead, a stock ranch takes the water some 4 mi. farther through its ranges.

The profile (Fig. 1) shows the relative elevations of the various parts of the system, but it is on too small a scale to show details of the topography. The country to the east of Olinda is very steep and rugged, consisting of a succession of narrow and deep gulches hewn out of the lava rock and covered with a dense coat of moss, ferns, vines and trees, a thick jungle through which progress is almost impossible without a trail. The general slope of the country throughout the length of the line is about 700 ft. per mi., and at times of storm each gulch carries a torrent of great velocity and of a magnitude demanding careful consideration.

In the maintenance of the line above Olinda the extreme rate of growth of the tropical jungle and the equally surprising rate of decay of ordinary timber are the striking facts. As most of the gulches are crossed on timber trestles, the maintenance of these trestles is

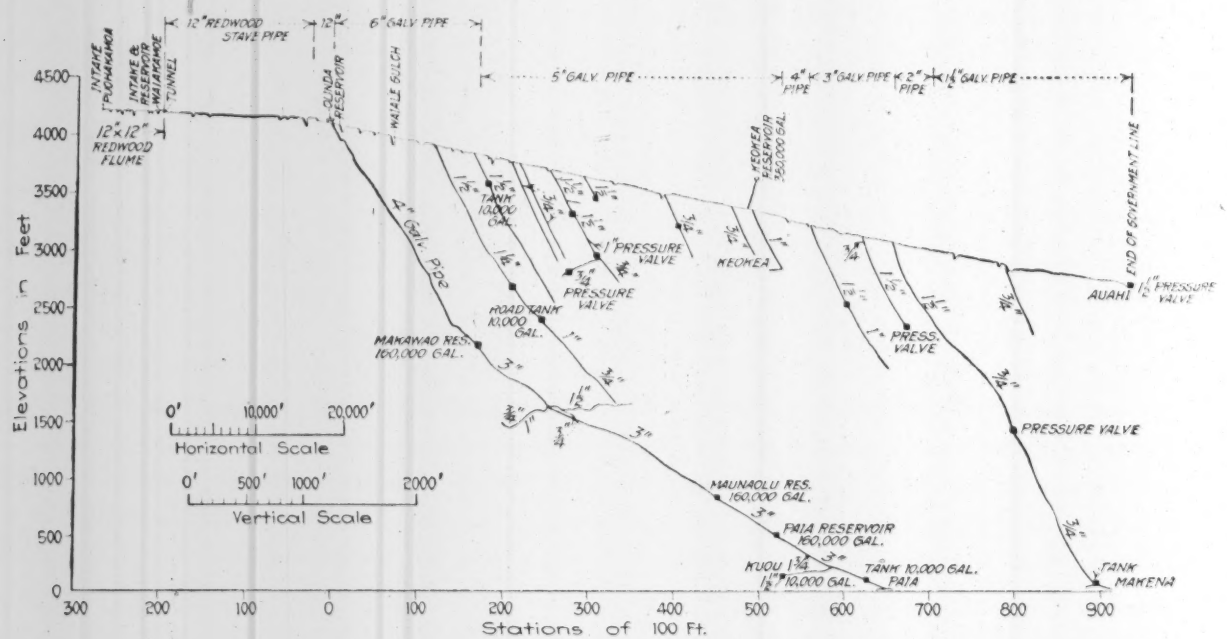


FIG. 1. CONDENSED PROFILE OF THE MAKAWAO WATER-WORKS, MAUI COUNTY, HAWAII

*County Engineer, Maui County, Wailuku, Maui, Hawaii.

a large factor. The Oregon fir, or "Nor'west" lumber, that was first used began to fail in two years, and decay was practically complete after five. Even though carefully protected by surface treatments of hot tar, the decay is easily apparent in six months' time. No creosoted or other protected lumber is here available without excessive cost.

A trail open to horses and pack animals is maintained as far as Waiakamoe, but only by the utmost labor. The rich humus that overlies the lava rock, with the continual rainfall and constant warmth and moisture, promotes vegetable growth at a rate unheard of in harsher climates. If a banana tree is cut down in the morning, by night it has sent up a 3-in. sprout from the stump, while a month's nonuse of a trail renders it difficult to distinguish the path it followed, so thick is the new growth.

The normal rainfall is the effect of the constant northeast trades, and its rapid variation with distance around the mountain is remarkable. From Waiakamoe to Olinda, a distance of 3.5 mi., the annual rainfall drops from 319.7 to 69.1 in. The heavy rainfall of the collecting area for the water-works is very well distributed, as is shown by the accompanying table. The longest drought on record was of three months' duration, during which time only light showers fell at Waiakamoe.

The normal rainfall on the southwest and south slopes of the mountain is comparatively light and occurs in sudden showers caused by a backlash of the vapor-laden trade winds around the bulk of the mountain. In contrast to the trade-wind rains are southerly storms causing the floods of the southwest and west slopes. These storms, called "Konas," sweep the islands four or five times in three years. The intensity of rainfall at such times is very great, precipitations of 10 to 12 in. in 24 hr. being common. The highest intensity on record for the Island of Maui was 24.30 in. in 3 hr., which was carefully observed in April, 1915, at Hana. The rainfall in 24 hr. at the same time was 28.20 in. (United States Weather Bureau records).

MONTHLY RAINFALL IN INCHES, ISLAND OF MAUI, HAWAII

Month	Waiakamoe, 5 Yr. Av.	Waiakamoe, 5 Yr. Max.	Waiakamoe, 5 Yr. Min.	Puohakamoa, 4 Yr. Av.	Puohakamoa, 4 Yr. Max.	Puohakamoa, 4 Yr. Min.
January	24 88	47 54	2 96	16 62	35 85	3 60
February	33 48	76 15	13 03	23 97	46 32	10 60
March	18 44	31 02	7 98	30 89	53 52	8 44
April	34 39	53 35	22 68	37 22	47 80	20 89
May	29 34	87 58	6 29	27 00	84 61	5 92
June	21 84	39 74	9 25	22 09	39 59	12 48
July	16 42	24 65	10 72	18 45	32 50	7 78
August	17 21	22 30	12 52	17 96	29 43	11 40
September	23 84	34 70	13 17	21 42	31 84	14 00
October	17 46	32 17	6 40	20 60	32 42	8 79
November	33 41	45 54	20 10	39 76	41 69	38 80
December	36 73	80 02	16 09	13 56	16 14	11 02
Yearly av. max. and min.	307 44	87 58	2 96	289 54	84 61	3 60
Long-time	319 7			303 5		

Flume, Reservoirs and Pipe Lines

The water from Puohakamoa is carried to Waiakamoe in a rectangular redwood flume. This flume is built of three 2x12-in. surfaced redwood planks; it is 10 in. deep and 12 in. wide, inside dimensions. It is covered with short pieces of the same planking.

The Waiakamoe dam has a height of 8 ft. It has a vertical upstream face of 2x12-in. plank, spiked to 6x8-in. studs 2 ft. c. to c. These studs are braced with 6x8-in. timbers at an angle of 45°, which form a log rollway in time of flood. The whole is placed on a concrete foundation at a narrow rock gap. Severe floods carrying many large logs have passed over this dam, and the only damage has been the occasional loss of a plank. The reservoir is of only 500,000 gal. capacity, the depth being limited by a porous stratum in the rock. It fills up badly with boulders and gravel at the time of flood, but is easily cleaned by sluicing and some handwork.

The line from Waiakamoe to Olinda is of 12-in. redwood-stave pipe. The short turns are made by special cast-iron elbows of various odd angles. These elbows are made with bells, into which the ends of the wood-stave pipe are leaded. The largest gulch is crossed by an inverted siphon, but in most places the line is carried across on trestles and timber trusses. The original construction was of Nor'west, or Oregon fir, but this timber decayed entirely within five years, owing to the constant soaking. Since then the bridges have been replaced, using redwood, and the trestles have been rebuilt with a native hardwood, Ohia, cut alongside the line and prepared in the form of rough round poles, notched and spiked into place.

FIG. 2. WAIALE GULCH CROSSING, MAKAWAO WATER-WORKS

At this point the pipe line is of 6-in. galvanized iron

The main line is of galvanized-iron pipe of 6- to 1½-in. diameter. The laterals are of the same construction, using smaller pipe. The original laying was very hastily done, and the line was left entirely exposed to the air (Fig. 2). The result was excessive expansion and contraction, which tore the threads out of the sleeves. The line is now buried with about 6 in. of earth cover. Gulch crossings are either on masonry piers or underground.

The reservoirs on the Makawao branch are rectangular concrete structures of 160,000 gal. capacity, roofed and screened. Keokea reservoir is of masonry and is bowl-shaped, with a capacity of 380,000 gal. It has been lined with cement plaster and with asphalt to check an early excessive leakage.

The new Olinda reservoir now under construction will have a capacity of 6,450,000 gal. It is flatiron shaped and is placed in a small valley behind a rock-fill dam 38 ft. high. It is everywhere excavated to a very poor quality rock and will be lined with reinforced concrete. The flood waters of the little valley are diverted by a storm ditch. With a fall of 700 ft. to the mile, it will readily be seen that the country does not offer sites for large reservoirs.

Pressure Regulation Under Difficulties

As will be evident from an inspection of the profile, the matter of pressure regulation is of great importance and some difficulty. The Makawao-Paia line is broken by three reservoirs and one 10,000-gal. tank, the lower

three equipped with float valves. The maximum static head on the upper reservoir is 1940 ft., but no float valve is in use here.

The main line has a pressure break at the Keokea reservoir. Somewhat below this it is intended to install a 4-in. Golden-Anderson pressure-regulating valve. The laterals, which run directly down the mountainside, have pressure broken at approximately 600-ft. (vertical) intervals by tanks and float valves or by pressure-regulating valves.

The earlier meters used broke continually under service pressures, but under the present conditions the meters now installed are giving excellent service. Some silt and small débris occur in the water. They are difficult to remove at the intakes and have given trouble in the valves and meters, but more careful screening and the installation of fish traps are eliminating this difficulty.

Water-Supply and Consumption

Accurate records have not been kept long enough for definite figures, but the following are estimates based on present conditions and records:

	Gal.
Normal annual runoff of Puohakamoa and Waiakamoe streams at 4,200-ft. elevation	500,000,000
Average consumption:	
Makawao branch, per day	150,000
Kula branch, per day	200,000
Total, per day	350,000
Total, per year	127,750,000

The total storage of the line after the completion of the Olinda reservoir will be about 7,800,000 gal.

Historical and Financial

The original construction of the line was in 1910-11, under territorial supervision and with a territorial appropriation. The Puohakamoa flume was built in 1912. From this time until January, 1916, the system was allowed to continue with no intelligent supervision or adequate maintenance. The result was a condition of chaos—an inadequate water-supply; trestles under the wood-stave pipe which threatened to fall at any moment and did fall with great frequency; a meter system of selling water in which barely 25% of the meters were registering; and a distributing system through which perhaps 33% of the water reached a consumer.

Since then new trestles have been built, the wood-stave pipe has been put in excellent condition, the main galvanized pipe has been buried, and the distributing system has been brought to fair shape. A universal meter system has been installed, giving excellent satisfaction to the consumers and to the water-works. The Olinda reservoir, which it is hoped will assure an adequate supply at all times, will soon be completed.

The water-works have been a heavy drain on the county from the time of their construction, but the installation of a meter system and careful supervision of accounts bid fair to allow the works to pay expenses and make a slight return on the investment. The rates are fixed by a county ordinance and are exceedingly low (15c. per 1000 gal.), considering the scattered consumption. The following are the principal items in the financial history and present status of the water-works:

Approximate first cost	$200,000
Approximate yearly cost of maintenance, 1913-15	9,000
Approximate yearly income, 1913-15	2,500
Cost of reconstruction, 1916	12,500
Present yearly income	7,387
Present cost of maintenance	7,648

The income is steadily increasing, and it is hoped that it may reach $10,000 a year without raising the rates.

Dry Reservoir for Flood Control on the Oder River in Germany

By Kenneth C. Grant*

The Buchwald reservoir is one of a group of 12 "dry" reservoirs, or retarding basins, built to control floods on tributaries of the Oder River in the Province of Silesia in southeastern Prussia. It is located on the Bober River near the headwaters, the drainage area above the dam being only about 23 sq.mi. The Bober empties into the Oder at Crossen.

The Buchwald dam, besides its interest as a work for flood control, is notable as being the first concrete dam built in Germany. It was constructed in 1903-05 by the Province of Silesia and the Prussian Government. It is 98 ft. high above the deepest part of the foundation, about half of this height being above the natural ground surface. The width on top is 10 ft., and the maximum bottom width is 57 ft. The crest of the dam is 750 ft. long and is arched upstream with a radius of 820 ft. The dam contains 36,200 cu.yd. of concrete.

The reservoir has a capacity of 77,660,000 cu. ft., all of which is kept empty and used solely for flood control. About 160 acres are flooded when the reservoir is filled to spillway level. This land is used for pasture and raising hay. It is rented for about $2.70 per acre per year. The average cost of the land was about $270 per acre.

At the left of the dam there is a concrete spillway 161 ft. long, with a freeboard of 6.6 ft. With a head of 2.6 ft. on the crest this spillway will discharge about 3180 sec.-ft. The crest of the spillway extends along the side of the valley upstream from the dam and delivers the water to a paved channel 33 ft. wide, passing through the dam and descending to the river channel below by a series of cascades paved with heavy rubble masonry. The channel of the Bober is paved for some distance below the lower end of the cascades. Near the left end of the dam, in the old Bober channel, there is a single outlet at the level of the stream bed, 41 ft. below the crest of the spillway. This outlet is elliptical in cross-section, with the longer axis horizontal, and has a cross-sectional area of about 27 sq.ft. With the reservoir full to a depth of 2.6 ft. on the spillway the outlet will discharge 1060 sec.-ft., so that, combined with the 3180 sec.-ft. that is then going over the spillway, the total outflow is 4240 sec.-ft., or 184 sec.-ft. per sq.mi., which was the maximum rate of discharge in the great flood of July, 1897. This outlet is lined with rubble masonry and is provided with a gate, to give better control of small floods. A channel paved with rubble masonry conducts the water from the outlet to the main channel, which it joins about 130 ft. below the dam.

There have been several floods of considerable size since the completion of the reservoir. The greatest of these was in July, 1907, when the reservoir was filled to within about 5.3 ft. of the spillway crest.

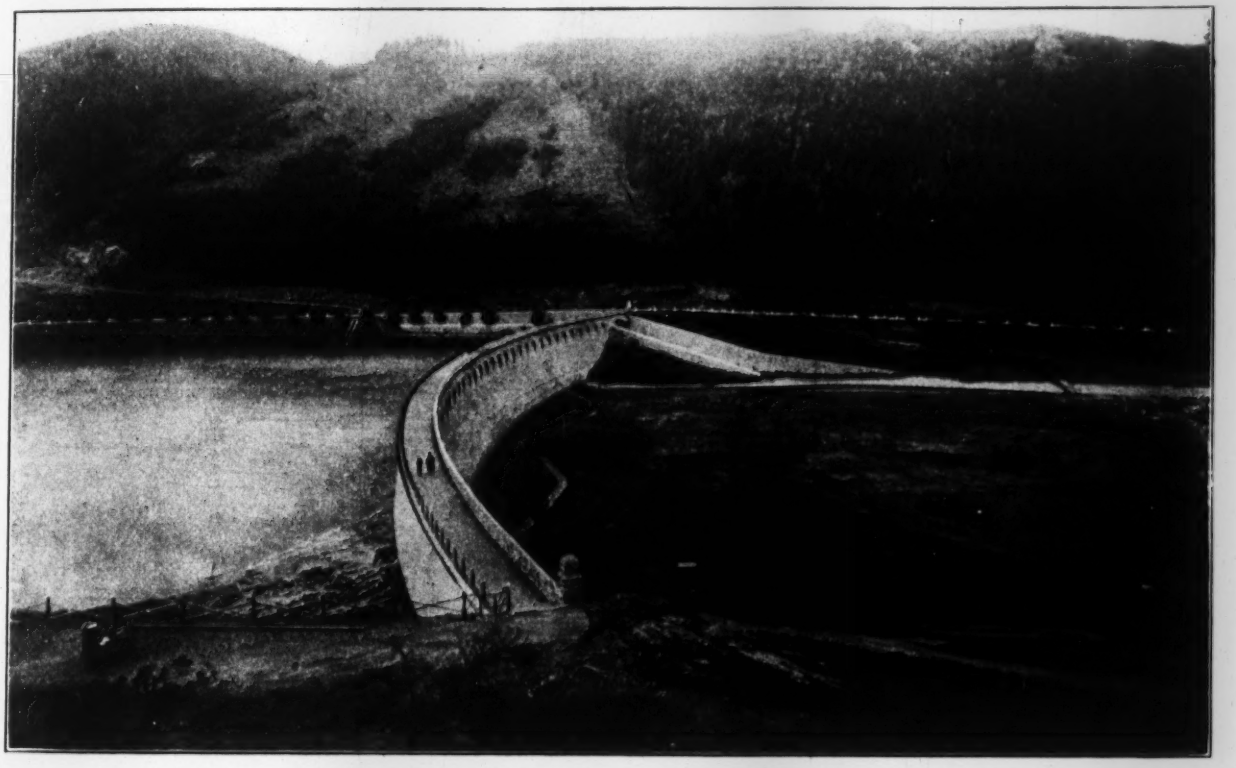
The concrete was mixed by machinery in the proportions of ½ part cement, ½ part trass, 1 parts sand and 8 parts crushed stone. The trass was added to the cement in order to give better resistance to the movements resulting from temperature changes, which it was considered would be particularly felt in this dam, by reason

*Assistant Engineer, Miami Conservancy District, Dayton, Ohio.

of the reservoir being empty the greater part of the year. In the outer surface of the dam a still smaller proportion of cement was used.

The stone, which was quarried at the site, consisted of conglomerate and graywacke. It was cleaned, washed and crushed, and then used in the concrete without screening, a sufficient amount of coarse, sharp quartz sand being added to obtain the above proportions. The tests of this concrete showed a compressive strength of about 1130 lb. per sq.in. after 28 days.

On the upstream face the dam is covered with a waterproofing compound. In most German dams this coating is protected by a layer of masonry about 3 ft. thick. In the Buchwald dam this masonry protection has not been provided, and the upper 23 ft. is exposed to the weather. An earthen fill on a 2 to 1 slope reaches to within 23 ft. of the top of the dam and protects the lower part of the waterproof coating. On the downstream face of the dam the concrete surface has been artificially roughened to improve its appearance. There has been some criticism of this treatment by German engineers, who have claimed that it has made the surface more porous and will permit rainwater to penetrate the concrete more readily and will increase the destructive action of frost.



BUCHWALD RETARDING BASIN FOR FLOOD CONTROL OF THE ODER RIVER IN PRUSSIA

The dam and appurtenances cost $204,000, and the land and damages cost $60,000, or a total of $264,000, or about $3400 per million cubic foot of storage. The Prussian Government paid 80% of the cost of the work. The Province of Silesia paid the other 20%.

The Buchwald reservoir is located about 35 mi. above the Mauer reservoir,[1] and its partial control of the 467 sq.mi. of drainage area above the Mauer dam is supplemented by five other retarding basins, built by the same authorities.

Concrete has been very little used in the construction of dams in Germany. The first German dam in which concrete was used in part as building material was the dam of the Solingen water and electric works, which is an earthen dam 43 ft. high, with a concrete core wall, built in 1901. It was at first proposed to build the core wall of rubble masonry, but the change to concrete was made because it enabled the more rapid completion of the dam. For the Urft dam, 196 ft. high, and the Nordhausen dam, 90 ft. high, both completed about 1904, the use of concrete in the body of the dam had at first been considered, partly because of the scarcity of suitable stone for rubble masonry and partly because of the greater speed that could be made if concrete were used. In both cases, however, it was finally decided to build the dams entirely of rubble masonry, owing to the considerably greater cost if concrete were used.

The arguments of the German engineers against the use of concrete in dams have been the high construction cost and doubts regarding the resistance of concrete to weathering. They have also felt that there is danger of the formation of cracks in exposed thin walls of concrete, due to the greater proportion of mortar than in rubble-masonry work. Their rubble-masonry work contains about 30 to 40% of mortar, while their concrete contains from 45 to 50%. The expansion coefficient of mortar is greater than that of stone, and German experiments on the movement of dams have determined that the expansion coefficient for rubble masonry is 0.0000078 for 1°, and for concrete is 0.00001228 for 1°.

[1] See "Engineering News," Apr. 3, 1913, p. 672.

Report on Collapse of Falsework on Spokane Concrete Bridge

By John C. Ralston*

SYNOPSIS—The 250-ft. twin-rib reinforced-concrete arch bridge on the line of Post St., across the Spokane River at Spokane, Wash., collapsed during construction on Feb. 6. The following report gives the details of the falsework that failed.

The Post St. bridge, the collapse of which at 3:20 p.m., Feb. 6, 1917, caused the death of three workmen, was intended to be a reinforced-concrete arch, twin-rib, open-spandrel, highway city bridge. It is located in the heart of Spokane, Wash., spans the Spokane River midway of the two falls and was to have had a clear span of 250 ft. with a rise of 33 ft. The two arch ribs were 6x6 ft. at the crown and 6x8 ft. at the haunch, connected by seven diaphragms.

FIG. 1. VIEW OF POST ST. BRIDGE LOOKING WEST AFTER COLLAPSE
The projecting rib in the foreground fell some three hours after the initial collapse

Its site lies midway between the Great Northern Ry. main-line double-track steel bridge on the north, distant about 50 ft., and the Washington Water Power Co. double-track steel bridge on the south, distant about 30 ft. A sheer escarpment of about 40 ft. of solid basaltic rock marks both banks of the river and thus constitutes an ideal site for the type of bridge contemplated. The bedrock presents nearly a level profile across the channel. River débris of small boulders, sand and gravel covers most of the bedrock to a depth of 4 to 6 ft., excepting at the west side of the channel, where the bedrock is exposed for a short distance, according to information given by the City Engineering Department.

The falsework for the bridge was designed by P. F. Kennedy, the engineer for Oleson & Johnson, the contractors. The erection of the falsework, together with the pouring of the ribs, was in direct charge of Mr. Kennedy until one week prior to the collapse, when Kennedy either fell or was knocked off the service bridge and was drowned. Thereafter the work was carried on under the direction of H. O. McCall, General Foreman, who no doubt followed the schedule of progress as laid out by the engineer. General supervision was under Morton Macartney, City Engineer, and his assistant, B. J. Garnett.

The falsework consisted of 18 bents spaced 12 ft. 4 in. c. to c., and each bent contained six carrying piles and one tie pile, capped with 12x12's, drift bolted with one ¾-in. round bolt per pile. False bolsters of 4x10 in., laid flat, over each pile, presumably continuous, constituted the longitudinal ties of all the bents at the top of the first story. This tie, however, seems to have been omitted between Bents 8 and 9 west, as shown by Fig. 4, although a partial substitute was put in in the form of a flat sway brace and spiked to the posts. This substitute seems to have been an unfortunate one. It is not apparent that the flat bolsters were drift bolted to each cap. On the contrary, it would appear from such meager evidence as now exists that the connections were made by toe-nailing with wire spikes these insufficient bolster members.

The accompanying elevation (Fig. 2), compiled on Feb. 8, 1917, by the city engineer's office from sketches in the contractors' office, shows that four lines of longitudinal sway bracing were carried from end to end. Existing evidence shows that this system of sways, with possibly two exceptions at the east end, was spiked to

*Consulting Engineer, Spokane, Wash.

the piles instead of being bolted. One workman stated that from one to three spikes were used. Fig. 3 shows that two or three spikes were used, but no bolts. None of the piles now standing nor any of those enmeshed in the débris that could be seen had been barked, so that clearly the sways were spiked through the bark, which generally is about 1 in. thick. This thickness, together with from 1 to 2 in. of soft sapwood, plus the thickness of the sway brace, gave a very insecure hold to an 8-in. spike and practically no holding value to a 6-in. spike, if such were employed.

A 3000-lb. hammer was used in driving the piles, and every pile is said to have been driven to refusal. General Foreman McCall and his workmen are clear on this point. The writer's long acquaintance with McCall justifies complete confidence in any statement he may make. The nature of the river bed is such that some piles might have come to refusal on boulders; and inasmuch as the depth of penetration at best was small, rigid horizontal and diagonal bracing would be necessary with a liberal use of through bolts and washers. It is reported by some of the workmen that, where known boulders were encountered, the piles in such cases were driven off center from a few inches to nearly 3 ft. in one instance.

The second story of the falsework (Fig. 3) was made up of 6x8-in. and 8x8-in. posts, built up of 4x8's, and in lengths from 4 ft. 8 in. to 22 ft. 11⅛ in., according to the schedule in the accompanying table. It does not appear how the two pieces making up the member were fastened, whether with spikes or bolts. The ordinary transverse sway bracing was used, according to the plan; but it is not shown whether it was bolted or spiked.

SCHEDULE OF SECOND-STORY POSTS

Mark	Number of Bents Required	Size of Posts * In	Length of Posts Ft	In
Bent 1	2	6x8	22	11
Bent 2	2	6x8	22	5
Bent 3	2	6x8 or 8x8	21	1
Bent 4	2	8x8	19	1
Bent 5	2	8x8	16	6
Bent 6	2	8x8	13	2
Bent 7	2	8x8	9	5
Bent 8	2	8x8	4	8

* The 6x8-in. posts were made from 6x8-in. sticks, but the 8x8-in. posts were made up of two 4x8-in. sticks.

Longitudinal sway bracing seems to have been used on alternate panels only.

The joists, with one or two exceptions, were 3½x15-in. Douglas fir and, together with some of the other stuff, were salvage materials from the floor of the old steel bridge that the new structure was to replace. This material, however, was all sound and not much over a year old. All joist had butt joints and rested without dapping on beveled shims, thus giving a minimum bearing. Unfortunately, the joists were toe-nailed to each other and to the shims, and the shims were similarly nailed to the caps. The end elevation shows the three joists immediately under the arch rib to have been spaced 2 ft. centers and the two outside joists spaced 2 ft. 8 in., without bridging or intermediate struts or spacing strips.

The elevation (Fig. 2) shows the sequence of sectional pouring. It will be noticed that all but a small part of the rib had been poured over Bent 5 west, when the collapse occurred. Half-yard batches were trammed from

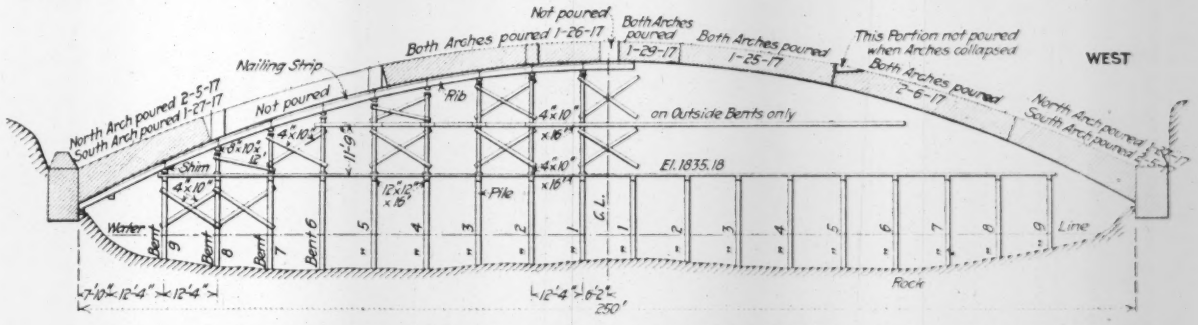


FIG. 2. OUTLINE OF POST ST. BRIDGE FALSEWORK, SHOWING PROGRESS OF PLACING CONCRETE

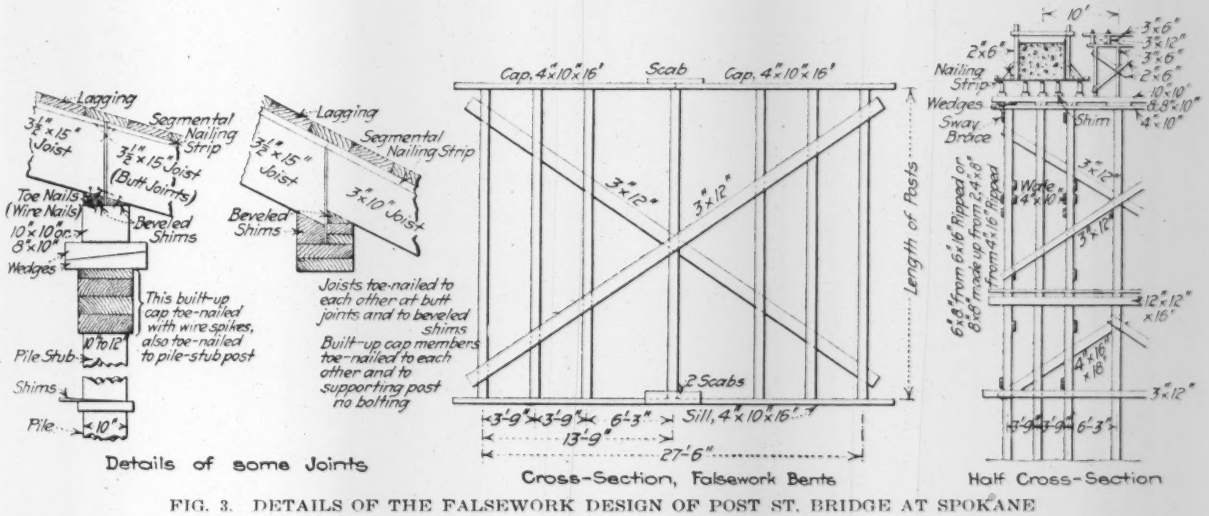


FIG. 3. DETAILS OF THE FALSEWORK DESIGN OF POST ST. BRIDGE AT SPOKANE

The elevation (Fig. 2) shows the sequence of sectional pouring. It will be noticed that all but a small part of the rib had been poured over Bent 5 west, when the collapse occurred. Half-yard batches were trammed from

FIG. 4. CLOSE VIEW OF BENTS 7 TO 9 ON WEST SIDE OF POST ST. BRIDGE
Pile tops from 9 to 12 in. diameter. Note absence of bolts and presence of shims under half-story round posts

the mixer and dumped onto an inclined chute, from which the concrete floated or was spread to place. The writer's information from the workmen is that the dump over this bent was nearly a vertical drop. This would give a drop ranging from about 9 to 15 ft.

Mr. McCall examined all the points at which he believed any distortion might occur due to loading, about 30 min. before the collapse came. He found everything apparently undisturbed and in normal condition. Notwithstanding that the drop distance was gradually being decreased as the forms filled, it was from this point, in his judgment, he stated, that the collapse started. It is possible that the cumulative result of the impacts finally developed the critical weakness in the falsework and thus tumbled the whole structure into a mass of inextricable débris.

FIG. 5. LOOKING EAST OVER BRIDGE RUINS

The writer is deeply sensible of the deplorable and untimely end of the designer within a week of the collapse and ventures to believe that, were Mr. Kennedy alive, he could explain away much that may seem obscure and perhaps even justify a structure that to some of the profession would appear inadequate for the purpose it was designed to serve.

[A later telegram from Mr. Ralston states that the coroner's jury has decided that the structure fell from insecure piling and the falsework was unable to bear the weight of the concrete. It recommends that the city inspect all such falsework. Mr. Ralston also reports as follows: Fuller investigations show that the piles had little if any penetration, although driven to refusal and that the spiked bracing was the only means of preventing the kicking off of the frame from the sloping rock surface. The piles were shamefully small and the upper frame of insufficient size, there being 3000 lb. stress in the three joists under each rib. The voussoir sections as poured were too long and the neglect simultaneously to pour opposite sections in the two ribs undoubtedly distorted the falsework which, combined with the general flimsiness of the frame, the impact of the dumped concrete and the overstressed joist, caused the wreck.—Editor.]

Concrete Road Pointers from Papers at American Concrete Institute

Three of the papers on concrete road construction at the recent annual convention of the American Concrete Institute, at Chicago, Ill., Feb. 8 to 10, furnish the material for the following paragraphs. The subjects touched on are the present condition of the famous Wayne County (Michigan) roads, the maintenance of concrete roads in Connecticut and the western New York State practice in construction.

Wear and Maintenance of Concrete Roads

As to the Wayne County roads, A. N. Johnson, Consulting Engineer of the Portland Cement Association, admitted that there are a number of cracks in the roads, but he held that real defects are only such things as form actual or potential hindrances to traffic, and that so-called defects are of small account if easy and cheap maintenance is possible. He said that all the Wayne County roads, built in the last two or three years, are in most excellent condition, but that three stretches of the older roads are in bad shape.

These three stretches, he said, are the ones that are used practically entirely by the anti-concrete road men when they are citing the Wayne County roads. They are as follows: (1) A stretch which was a very poor job when built; it was not accepted by the commissioners as built, but was accepted with some hold-backs on pay. It was afterwards coated with tar. It has never proved satisfactory. (2) A section built of unwashed aggregate on which traffic was allowed too soon; it commenced to show decided signs of wear within three months, and was soon covered with a tar coating. (3) A section which never was in very good shape; it had apparently had some peculiar difficulty during construction. Mr. Johnson did not elaborate on it.

Most of the wear on concrete roads is at the joints, according to W. L. Ulrich, of the Connecticut State Highway Department. Other causes of maintenance expenditures are: (2) Small holes from local defects; (3) poor sand; that is, sand that has not good resistance to abrasion (in curing this, tar is broomed over the weak spot); (4) Concrete too wet; poor floating (this causes flaking, but is not of sufficient importance to require repair); (5) Longitudinal cracks which can not be accounted for so well, but probably are due to bad drainage and consequent dropping of the slabs at the sides. This is now taken care of by reinforcement.

Mr. Ulrich gave the following average costs of maintenance of roads in Connecticut for the last two years: Concrete roads, 25 mi., cost of maintenance and repair, $38.63 per mi., or 0.4c. per sq.yd. of surface for annual maintenance; for drainage, $28 per mi. per year, or 0.3c. per sq.yd. giving a total of 0.7c. per sq.yd. per year. For all other types of road amounting to about 1000 mi., the cost was $585.18 per mi. per year or 6¼c. per sq.yd. These other roads average about three years older than the concrete roads.

Construction Pointers

William M. Acheson, Division Engineer, New York State Highway Department, read a paper "Essential Features for Successful Construction of Concrete Roads," which contained the following points:

Where soil conditions develop that cannot be corrected by replacing with a more stable soil, a subbase should be laid. From a study of the highways which were built in New York, Division 9, during the past two years, he has found the following type of foundation course the best for concrete pavement.

After the necessary excavating has been done and the subgrade properly drained, a layer of clean gravel from 2 to 4 in. in thickness is spread over the bottom. On this a layer of quarry or field stone is placed to the required thickness, depending on soil conditions. After the voids have been filled with clean sand or fine gravel and consolidated, the stone should be covered with at least 2 in. of coarse sand. This last mentioned sand layer serves the double purpose of regulating the subgrade and acting as a cushion to take the impact off the pavement proper.

Mr. Acheson is using reinforcement at every place where there is any doubt as to bad soil conditions. One of the essential features of the reinforcement, he said, is to be sure that it is in the proper location as to cross-section. It has been his practice to lay the first course of concrete and on this place the reinforcement, usually about 2 in. below grade by the use of wire hooks. It is then covered with the necessary 2 in. of concrete and the finished surface struck off.

Hard and fast rules should be laid down in regard to the aggregates, he said, for these were the factors in the successful construction which should never be deviated from. In this detail he said he differed from some engineers. If in certain localities the proper quality of material is not available without importing, and concrete was prohibitive on account of the resulting high cost, he said he would not attempt to build a concrete road. The question of proper coarse and fine aggregate is paramount in concrete road construction.

In the southwestern part of New York State, which is known as the lower tier, are sections which have been known for the scarcity of sands of the proper quality. In this section there were constructed a number of gravel concrete roads with thin bituminous tops, which were complete failures. By a careful material survey of this section, sand was found which passed the requirements by being washed. To have commercial sand and gravel companies install washing plants was a task, but this has finally been done, and it will not be long before contractors can be induced to install their own plants.

Surface Treatment

The surface of a concrete road should be screeded by means of a templet drawn with a short sawing action at right angles to the axis of the road, according to Mr. Acheson. A heavy screed should be used, and at the same time it should not be necessary to move this screed over the concrete surface more than once. Following this a "smoother" should be used. This is frequently referred to as a float, but the word float is a misnomer. The real intention is to smooth the surface so it will conform to the finished cross-section. This smoothing tool should always be made of wood.

Sprinkling with hand pots should be started as soon as the concrete surface will stand it. Hand pots should be used because the pressure from a hose on the first sprinkling is usually too severe on the surface. This should be done from one to two hours after the concrete

is placed. In this connection it is very essential that the hand sprinkling should be done several times before sod or earth protection is placed over the surface, and then after it is placed the pavement should be sprinkled at least twice during the day and once at night.

Mr. Acheson believes in a heavy split float for taking care of the joints, and the use of a long-handled float; which enables the operator always to work in a normal position over the bridge, also eliminating an additional man, who is necessary when hand floats are used.

The finishing should always be within 10 to 15 ft. of the screed, and this is impossible if the concrete is too wet. He advocates the brooming of a concrete road for the reason that the marks which the broom makes in the pavement aid in holding the moisture during the curing season. Care should be taken, however, to see that the broom marks are not too deep so as to start spalling and impede surface drainage.

Joints in the New York State work are placed every 30 ft. The reason for the adoption of 30-ft. joints is a practical one. It has been found that the transverse cracks which occur in the pavement average 30 ft. apart, and later inspections have demonstrated that this was a good decision, although the Highway Department is in an experimental mood and probably will try joints at greater distances.

One of the most important parts of a contractor's road plant in the construction of concrete roads is the water-supply. Mr. Acheson would advise at least a 5-hp. engine with a pump capacity of at least 200 gal. per min. The pipe line should be at least 2 in. and should have a tap at least every 200 ft. Wire wound hose should be provided long enough to reach half way between the taps. A great many mistakes have been made, he said, in regard to this particular feature.

Tile Drainage of Irrigated Land in Utah

By J. C. Wheelon*

During the spring of 1916, arrangements were concluded to install a tile drainage system on a 10,000-acre tract of the Delta Land and Water Co.'s project known as the "South Side Tract." This is an exceptionally beautiful and fertile tract, as deserts go, lying as smooth as a billiard table and having a fall to the south of 7 ft. per mi. The development work is being done under the Carey Act, and the company has installed the irrigation works, which (with the lands) will be turned over to the farmers. The farm tile drainage system is being installed to forestall the damage that usually follows the practice of irrigation, due to water-logged conditions of the soil and the concentration of alkaline salts to the detriment of growing crops. This trouble is indicated in the older irrigated settlements in the immediate vicinity.

Work Done by Force Account

The drainage work is done by force account, and the cost will be added to the price of the land to be sold to the settlers, who are employed to do all the work for which they have time and proficiency. The machinery, camps and shops are owned by the Delta Land and Water Co. and will be used on other tracts of land with a view to combine tile drainage with irrigation in future operations where this is found essential to the success of new districts. A. M. McPherson, project manager of Delta, Utah, has organized this drainage system as a branch of his project work, and with the able assistance of C. C. Cramer, his chief engineer, has established working camps, shops, etc., on the tract, where the closest attention can be given the work. The main camp is seven miles east of Oasis, a station on the Salt Lake & San Pedro Ry., the nearest railway point.

The drain tiles are furnished by the Utah Fire Clay Co., of Salt Lake City. The hauling from Oasis is done by farmers' teams and is paid for by the ton. The tiles are delivered along the route and distributed close to the proposed tile lines, as indicated by the surveyor's flags along the route. The tiles are placed many miles ahead of the excavation in order that they can be laid as soon as the trench is dug.

Electric-Lighted Ditching Machines

Three large 75-hp. gasoline traction ditching machines of the wheel-excavator type are now in use, with one or possibly two more to be ordered later. Two were built by the Buckeye Traction Ditcher Co., of Findlay, Ohio, and the third by Pawling & Harnischfeger, of Milwaukee, Wis. These machines are equipped with electric-lighting systems to enable the operation of night shifts. The maximum capacity in good ground in a trench 7 ft. deep and 20 in. wide is 2400 lin.ft. in 10 hr. for each machine. Owing to bad conditions that are encountered almost daily, the average is very good at 1400 ft. per 10-hr. shift.

Each machine operator is supplied with a blueprint map of the lines in his district. This indicates the survey, the location of the hub stakes, the flags at the intersection of branches, the depth to grade at each hub, the sizes of the tile to be used, the location of points where the size of tile changes and other useful information.

The soil is a sandy-clay loam for a depth of 3 to 4 ft., with a gradual change to fine sand as the depth increases. There is some quicksand at the lower depth of the trenches in places. As this kind of soil caves easily when waterlogged, a special steel shield is attached to the frame of the machine, just behind the digging wheel. This shield extends down to the bottom of the finished trench and forms a cab, which prevents the side walls of the trench from caving and which also carries the operator who lays the tile. The operator lays the tile as fast as the machine moves along, the tile being handed down to him by a man on the ground outside. The tile of all sizes are made in 2-ft. lengths. No 1-ft lengths of tile are used, as the longer tiles make for a better vertical as well as horizontal alignment and improve the flow line.

Some Handwork Necessary

One man follows behind the machine with a shovel and covers the tile with about a foot of earth, so that if the trench caves, this pad of filling will protect the tile from being thrown out of alignment by heavy clods of earth. The lines are left in this state of partial completion until several days have passed, so that if any poor workmanship has escaped the inspector, the accumulating waters flowing in the new drain will discover it and it can be remedied before the trench is filled.

*Consulting Engineer, Garland, Utah.

The filling of the trenches is done with two teams of horses and drivers with a 3x12-in. plank 18 ft. long, strengthened with a truss to prevent its breaking. A team is hitched to each end of the plank, which is held on its edge by the weight of the truss at the back. The plank is laid across the trench, being of such length that one team travels on the outside of the spoil bank, while the other team travels on the opposite side of the trench. The team on the spoil-bank side travels somewhat ahead of the other, giving a slant to the plank that rolls the earth into the trench in a constant spray of fine soil that makes an excellent job. The filling is finished by plowing a back furrow onto the filled trench to provide dirt for settlement.

Some of the work is necessarily done by hand. Where permanent ditches and canals are crossed, special care is taken to prevent the water from finding its way into the tiles and exhausting their capacity. For this purpose concrete is poured over the tile while being laid, so that a thin jacket of concrete is formed for about 20 ft. each way from the center of the canal. Some difficulty was had in making the new earth over the trenches hold water in these canals. The new work settled and let out the water, filling the unfinished trenches with mud and water for many rods along the work. This was remedied by building a "riser" at each end of the jacketed section. This was a thin wall of concrete, about 5 in. thick, the full width of the trench and extending from the end of the jacket to the surface of the ground. Since this no trouble has arisen from that source.

Organization of Machine Crews

The crew for each machine consists of an engineman, who operates the apparatus and gages the course and depth and who can keep the machine in running order; one man to do the oiling, assist the engineman and set the targets on the line ahead; one man, in the trench cab, to lay tile; one to supply him with the tiles; and one man to cover the tile and help at other work, or five men for each crew. There is a general machinist who is available to go from one machine to another as troubleman, and an inspector who looks after all the work. A man with team supplies fuel, cement, sand and manhole sections, and moves concrete crew, etc. Two men do the concrete work for the several crews. These outfits are all doubled, as they work the machines in two 10-hr. shifts per day.

Preceding the work a complete map of the area to be drained was made, showing contour lines for every foot in elevation. Profiles of the water table were made by the use of 5-in. sounding wells 6 ft. deep, kept intact by a sheet-iron pipe and located ⅛ mi. apart both ways. As most of this tract had been farmed and irrigated for three years, these sounding wells are useful to determine the progress made in lowering the water during the prosecution of the drainage work. From this map the working maps were made showing the lines of tile, the manholes, peep wells, target hubs every 500 ft. (at which the depth to grade was shown), intersections of branch lines, open outfall ditches, all canal and road crossings, the sizes of the tile to be used and the points at which a change in the size of tile is to occur; also, any other information that will make for accuracy in fieldwork. About 15 mi. of open canal were built as outfalls and to take surface waste.

The largest tile are 12 in. in inside diameter. The smallest are 5 in. in diameter, about 70% of the entire system being 5-in. tile. The whole system is laid out on a uniform gridiron plan as near as possible, with the lines 450 ft. apart. The depth of trench is 4 to 7 ft., the average depth being 5.8 ft. The work is estimated to cost $20 per acre, everything complete.

Sand and Gravel Mixed at Source for New York Subway Concrete*

By J. G. Steinle†

In the New York City subways now under construction considerable difficulty has been experienced in finding adequate storage for concrete aggregates, especially in the lower parts of Manhattan, where the streets are narrow and the traffic heavy. This, together with the increased cost of cartage and the difficulty of keeping the numerous mixers supplied with the proper quantity of each aggregate, led to mixing the coarse and fine aggregates in the proper proportions at the source of supply and ship them ready mixed to the works.

At the present time there are two companies which ship the mixed aggregate. One company dredges from Long Island Sound, and separates the sand and gravel into various sizes, known commercially as 1½ in., 1 in., ⅝ in., ⅜ in., coarse grits, bird sand and rubbing sand. These various sizes are then remixed on conveyor belts in such proportions so as to make specification sand and gravel, and in passing from one belt to another and through chutes are properly combined.

The other company mines its product from the bank, washes it thoroughly, and then separates it into specification sand and gravel. At this plant the sand and gravel are hauled in cars to a loading pier especially equipped for mixing and loading. There are two hoppers on this pier, one for gravel, and the other for sand, which receive the contents of the cars and discharge it on a conveyor belt. The bottom of each hopper is closed by a bucketed wheel, which is so geared that the gravel hopper empties at twice the rate of the sand hopper. The mixture is then carried on the conveyor belt to the chute which delivers it to the boat.

In order to prevent segregation in loading, the boats are moved back and forth under the chute, which is always kept in a vertical position, or as nearly so as possible, because when the mixture is fed to the boat from a chute at any other angle, the larger particles, possessing greater kinetic energy, separate from the finer particles. The combined aggregate is not allowed to pile up, but is spread uniformly over the boat in layers 2 ft. deep. Field tests show that material on arrival at the mixer, after being unloaded from the scows and hauled through the streets is very little segregated, the proportions remaining practically the same as at the plant. In case of the 1½-in. mixture, it has been found that if it has been mishandled or rehandled too many times, it may become segregated, while ¾-in. gravel, mixed with sand, may be handled quite freely without danger of serious segregation, hence we find that the greater the variation between the extreme sizes of the component parts the greater is the danger of segregation.

*Part of paper read before American Concrete Institute, Chicago, Feb. 8, 1917.

†Assistant Engineer, Public Service Commission, New York City.

Notes from Field and Office

A sand that is difficult to handle—Driving concrete sheetpiles accurately—Partial paving of a street—Fill 130 ft. high to replace steel viaduct—Submerging 72-in. iron intake

"Rock Flour" Causes Difficulty

An unusual formation that many engineers and contractors have never before encountered is the cause of a suit for extra payment by a contractor on the sewerage works of the Metropolitan Sewerage District (Massachusetts). Borings along the line of the proposed sewer disclosed the presence of this unusual formation, but the difficulty of handling it was not recognized by either engineers or contractors.

The material is said to be a pure sand, but is finer than ordinary cement, which it resembles both in color and texture, although much more dense or compact than cement. When wet, this substance has the consistency of bread dough and is handled with great trouble. A shovel or other implement of excavation is forced into it with difficulty; and when the implement is lifted, the material flows away on all sides. It is said that a pile of this material as high as a man's head still retained the foregoing characteristics after remaining on the ground all winter.

The contract price for the sewer work was about $35,000, but it is alleged that the work cost the contractor just twice as much. The contractor is now suing to have the district reimburse him for part of the unforeseen cost.

Driving Concrete Sheetpiles True to Line and Position

By E. A. Bailey*

The construction of the Sacramento weir at Sacramento, Calif., a general description of which was published in *Engineering News*, June 22, 1916, p. 1204, includes the driving of a row of concrete sheetpiling 2000 ft. long under the crest of the wier to prevent seepage and consequent undercutting of the structure. The piles, extending through the sandy loam surface soil and penetrating a depth of about 4 ft. into a stratum of clay, vary from 18 to 26 ft. in length. They were designed, as shown in Fig. 1, with a slope, or as locally termed a "snipe," of 12 in. in 24 on the driving point. The contractor, believing that this was too sharp a point and that it would cause excessive friction, making the piling hard to drive, cast the first piles with a snipe of 4 in. in 12 in. When these piles were driven, however, it was found that the snipe given them by the contractor was insufficient to keep the point of the piles crowded tightly against the preceding pile, with the result as shown in Fig. 2. The points were then sharpened by chipping off the concrete to about the snipe given in the original design, after which no further difficulty was experienced in keeping the piling together.

The surface of the ground was soaked by means of water standing in the trench in which the piling was driven. No water jet was used. The piling was driven

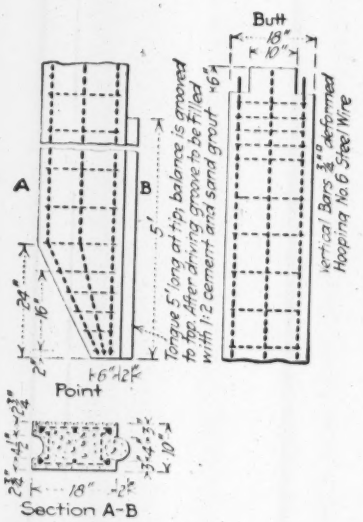


FIG. 1. CONCRETE SHEETPILE USED IN SACRAMENTO WEIR

with a Vulcan No. 1 steam hammer. The weight of the hammer was about 5000 lb., with a stroke of 30 in.

In driving the piling with heads constructed as designed the heads shattered badly in spite of any cushion that could be used under the hammer. A steel driving cap was made, which was placed around the head of the pile, the space between the pile and the cap being filled

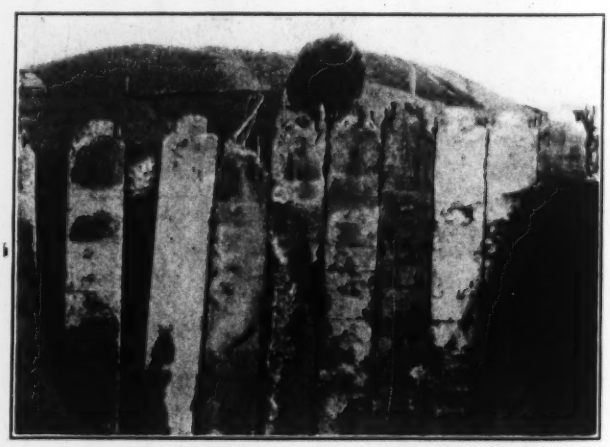


FIG. 2. EXPOSED SHEETPILES, SHOWING BATTERED TOPS AND "CREEP" OF PILES

*Flood Control Engineer, State Reclamation Board, Sacramento, Calif.

with plaster of paris, as shown in Fig. 3. It was found that piling thus treated could be driven within 15 min. after the application of the plaster of paris, the best results being obtained by allowing about half an hour to elapse. Driving could be postponed as long as 24 hr. but it was found that beyond that time the plaster of paris had become so brittle as to disintegrate and allow the head of the piling to break as badly as it did without the plaster of paris. The last 200 piles were cast with

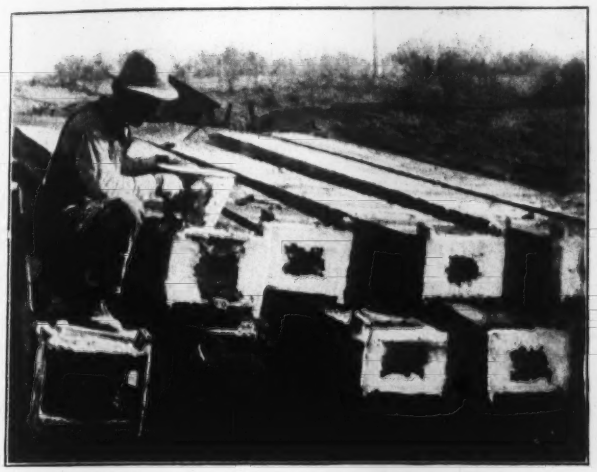


FIG. 3. PUTTING A PLASTER OF PARIS DRIVING CAP ON CONCRETE SHEETPILES

the head the full size of the pile, and these were successfully driven without the plaster of paris cap.

In Fig. 2 it will be noticed that the side of the groove on two of the piles was broken off for a considerable distance. This was probably caused by the point of the pile being deflected. There had been an old break in the river levee at this point, which had been repaired, it is said, by sinking a barge filled with cobbles. The driving was excessively hard at this point, which was taken to indicate that this obstruction had been encountered by the piling.

Excavations are being made for the piers at intervals of about 40 ft. to the depth as shown in Fig. 2, though not so wide. These excavations have progressed along about half the length of the sheetpiling, and thus far no breaks have been discovered in the piling except one not far from those shown in Fig. 2.

Wide Street Paving in Varied Strips To Meet Traffic Requirements

At Royal Oak, Mich., the problem of paving Washington Ave., 65 ft. wide between curbs, was solved by laying a narrow strip of concrete pavement on each side and leaving the remainder of the street for future treatment. A special feature of these concrete strips is that they are laid slightly below the finished grade and will eventually form the base for a future asphalt covering. This work extended for about 2600 ft.

The construction with concrete strips is shown by the cross-section, Fig. 1. The street is 65 ft. wide, with a parabolic curve giving a crown of 7 in. In the center of the street is a double-track street-car line of the Detroit United Ry. The rails are laid temporarily at the grade of the concrete paving, or about 2 in. below the established grade for the future asphalt surface. In each driveway is a 9-ft. strip of concrete paving 7 in. thick. This was originally designed to be of one-course reinforced concrete, but was changed to two-course concrete without reinforcement. The space between each strip

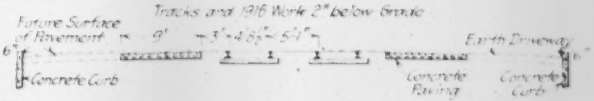


FIG. 1. STREET 65 FT. WIDE WITH TWO 9-FT. STRIPS OF CONCRETE PAVING, AT ROYAL OAK, MICH.

and the gutter is an earth roadway, to be paved in future with asphalt on a concrete base. The track space is not paved, but is filled with crushed granite and limestone screenings for the full width between the concrete strips.

For a distance of 1467 ft., where the width is less, the street is fully paved with brick and concrete. Here the track construction is of the standard design of the Detroit United Ry., shown in Fig. 2. The tracks are laid with 7-in. 91-lb. T-girder rails, in 60-ft. lengths, with 227-lb. cast-weld joints. They are connected at 6-ft. intervals by flat tie-bars $\frac{3}{8}$x1$\frac{3}{4}$ in., with threaded ends passed through the rail webs and secured by nuts. The rails are spiked to wood ties 6x10 in., 6 ft. 8 in. long, 20 ties to a rail, with a spacing of about 3 ft. c. to c. For each track there is an 8-in. concrete base, the 28½-in. space between the slabs being trenched for a tile drain and filled with slag. For paved streets each tie rests on a 1-in. sand cushion, and concrete is filled around and over the ties, covering them with a 2½-in. layer.

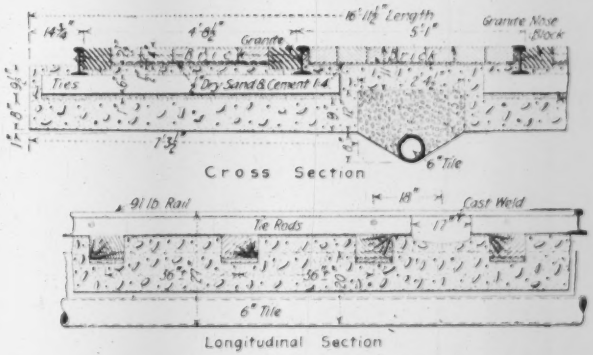


FIG. 2. STANDARD TRACK CONSTRUCTION FOR PAVED STREETS, DETROIT UNITED RY.

For brick paving there is a ½-in. sand cushion. At Royal Oak, however, the paving between the rails is of concrete, with granite nose blocks along the inside of each rail to form the wheel groove.

In doing the trackwork a single temporary track was laid at one side of the street, and car movements were governed by hand-operated block signals, consisting of a group of electric lights on a post at each end of the single-track section. The concrete work was done by the R. D. Baker Co., of Detroit, which had the contracts both from the village and the railway company. The trackwork was under the direction of John Kerwin, Superintendent of Tracks, Detroit United Ry. The Southern Michigan Engineering Co., of Royal Oak, Mich., acted as engineer for the village.

Steel Viaduct Replaced by Fill Dumped from Second Steel Trestle

When the Bessemer & Lake Erie R.R., in 1896, built its Allegheny River bridge, it was foreseen that the growth of traffic would eventually render double-tracking of the road necessary. Therefore foundations and footings capable of carrying the piers of a double-track bridge were provided, although the masonry was only carried up in single-track width above water level.

The increase in traffic came, until the throttling effect of this half-mile section of single track in what has become largely a double-track road influences the capacity of the entire system. But along with the growth in the volume of traffic came the tremendous increase in weight of the units in which and by which it is moved, to upset calculations. Today double-headed trains of one class of engines on reaching the bridge must stop and send one of their engines over ahead or put it on behind as pusher, to avoid concentrating the engine loadings.

Faced with the problem of providing another track over the river and with this growing inadequacy of the existing spans, the railway company decided that in the interests of ultimate economy and safety it was better to scrap the entire superstructure than to add to and reinforce it. The new plan provides for placing a third of the length of the existing bridge once and for all beyond the reach of depreciation and obsolescence, by converting it into fill.

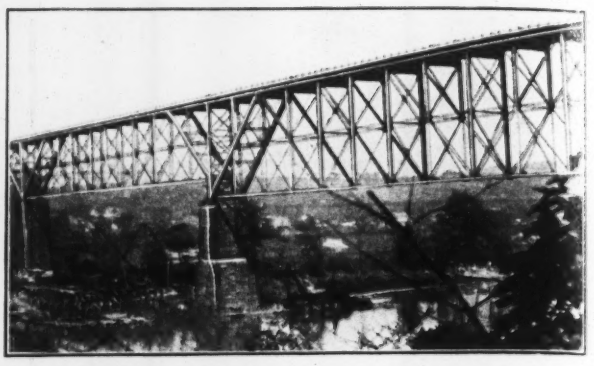


FIG. 2. GENERAL VIEW OF RIVER SPANS, PRESENT ALLEGHENY RIVER BRIDGE, LOOKING NORTH

A permanent embankment 130 ft. high is therefore to replace about 1200 ft. of steel viaduct at the north end of the Allegheny crossing, leaving an ample clear waterway of about 2400 ft. under the river spans. It will contain 1,200,000 cu.yd. of slag and is being placed at a rate of about 3500 cu.yd., or 120 cars, a day.

It is common practice in Western railroad practice for framed timber trestles to be erected during construction

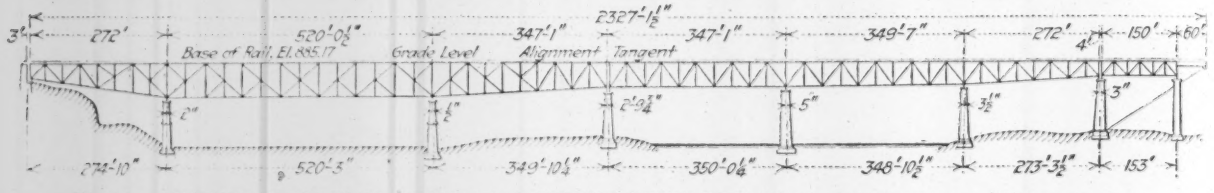


FIG. 1. OUTLINE ELEVATION OF NEW ALLEGHENY RIVER BRIDGE OF BESSEMER & LAKE ERIE R.R.

The old bridge (see Figs. 1 and 2) is on a grade of 0.18% going toward Pittsburgh; the new base of rail will be level, starting from the same elevation at the south end and running 17 ft. above the old grade at the north end. The new superstructure will be designed for two lines of E75 loading, and there will be two triple continuous trusses and one simple truss span, all of "high" steel. Work now under way consists of extending five of the old piers to double-track width, building two new piers and one abutment and making the north fill. The "Bessemer," a United States Steel Corporation subsidiary, brings ore from the Great Lakes to the plants of the parent company in the Pittsburgh district. It also has to dispose daily of a large tonnage of refuse from those mills and furnaces. This fact affects considerably its construction economics. The profile for its recent grade-reduction reconstruction shows the far greatest portion in fill, with no attempt at balancing. While its cuts cost it presumably as much as any other road, its fills cost much less; in fact, the slag must be dumped somewhere.

of a line and used for a number of years until eventually buried in fill, made by dumping from them. But it is not often in any part of the country that a perfectly serviceable steel viaduct is treated in this way. In the building of the north embankment of the Allegheny River bridge two such viaducts, side by side, are being buried. One of these is the main-line trestle, which is left in place to carry traffic, as traffic must be carried until the completion of the new earthwork. The second viaduct, Fig. 4, was erected alongside as a dumping trestle, because train movements over the bridge are too incessant to allow dumping from the main track. The high

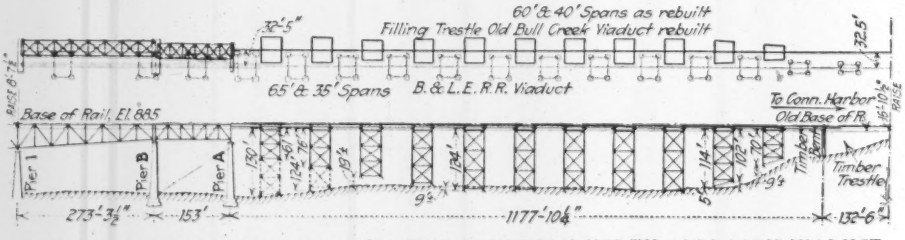


FIG. 3. POSITION OF FILLING TRESTLE ALONGSIDE NORTH APPROACH VIADUCT

north bluff made it impracticable to get down to a low pile dumping trestle such as had been used in making the 1,000,000-cu.yd. Culmerville fill a few miles away. Culmerville embankment, which has been under construction for three years past, required four pile trestles to raise it to its maximum height of 185 ft.

The line change at Culmerville released from service a steel viaduct 135 ft. high and 1400 ft. long. This, then, was taken down, and the towers and tower spans were

brought to the new Allegheny bridge site and rerected alongside the main-line trestle. In order that the embankment might be centered on the new bridge line, it was necessary to crowd the filling trestle over to within 32.5 ft. of the centerline of the old bridge, as shown by the pedestal locations in Fig. 3.

The old bridge viaduct has 65-ft. and 35-ft. spans, while Culmerville (or Bridge 10) viaduct in its original location had 80- and 40-ft. spans. The dumping-trestle towers were erected on 100-ft. centers, to clear the other towers, and 60-ft. girder spans that the railroad had on hand were used instead of the 80-ft. spans. The 60-ft. spans were narrower and shallower than the 80-ft. spans and so rest on a pair of I-beams, spanning the column caps at each end. Ties on the dumping trestle are spaced 2 ft. on centers.

Some other adapting was also required because of the varying height of the Culmerville towers, the center ones being about 10 ft. too high and the ones erected toward the Allegheny River end being from 19 to 69 ft. too

FIG. 4. VIEW OF FILLING TRESTLE AND PIER A, NORTH APPROACH TO ALLEGHENY RIVER BRIDGE

short for the new location. One story of new steelwork was added to one tower (Fig. 3), two to another, one that lacked but 19 ft. was set up on pile bents of that height, and the foundations for the ones that were too long were set in pits about 15 ft. below the surface. In these last cases the foundations were 4 ft. of concrete on gravel; where the column footings came above the ground level, pile pedestals were used. All the field connections were bolted.

Handling the Slag for the Fill

The trestle can accommodate about 30 cars at one time, and 120 cars containing about 3500 cu.yd. is the amount of refuse usually received at the bridge site daily. It is loaded in cars of various types, some of which require much shoveling to empty, as the mills must load whatever cars come to hand to get the waste out of the way. Practically all the refuse consigned to this fill is a vitreous openhearth slag, along with some blast-furnace slag. This material makes a stable fill, with a minimum of slippage and settling, and takes about a 1½ to 1 slope. It varies in size from dust to two-man-size lumps. The big pieces batter up the bracing of the trestles badly; but since the towers are constantly shortening in height above the fill, this effect is not serious.

The dust threatened to be more troublesome, as a breeze would float it over the surrounding farms and create a serious nuisance. A standard 50,000-gal. water tank was erected on the bluff, and every car is well wet down before being run out on the trestle. Besides keeping the dust from flying over the country roundabout, this treatment improved working conditions materially for the men engaged in cleaning out the cars.

There is one type of mill refuse, however, that cannot be handled with even this precaution. This is flue dust. It will not wet down, being practically impervious, and cars known to contain it are sent on to other locations better adapted to its handling. Occasionally an unpleasant surprise is sprung by a car half-filled with flue dust, concealed under a layer of some other material.

This work is being done by company forces, under the direction of H. T. Porter, Chief Engineer. W. H. Slifer is Resident Engineer.

Laying a Submerged 72-In. Cast-Iron Intake Main at Syracuse, N. Y.

(Contributed)

To serve as an intake for the water-supply of the Solvay Process Co., Syracuse, N. Y., 1250 ft. of 72-in. cast-iron pipe has just been laid in the bed of Onondaga

FIG. 1. FOUR LENGTHS OF 72-IN. PIPE ON WAYS READY FOR LAUNCHING

Lake at depths varying from 12 to 60 ft. This is one of the largest submarine pipe-laying jobs on record. The work was done by the Great Lakes Dredge and Dock Co., Buffalo, N. Y.

The shore end of this pipe line was cast into a reinforced-concrete well, the bell end of the pipe being in the well, from which point the pipe-laying in the lake began. The pipe line was laid in sections of 48 ft., made up of four pieces of pipe 12 ft. long, each weighing 8 tons. The sections of pipe were put together on a wharf, lined up, leaded and calked with plumbers' oakum, leaving not less than 2½ in. of the joint to be poured with lead. The spigot on the end of each 48-ft. section was specially

tapered, and this point was calked and poured ashore and then pulled apart, so that no calking under water was necessary.

After the joints were calked and leaded, wooden bulkheads were placed over each end of the section, held in place by 1¼-in. rods running the whole length of the pipe on the outside. These bulkheads were provided with gaskets that made them water-tight. A 5-in. gate valve was placed in each bulkhead, so that water could be let into the pipe when it was ready to be sunk into place.

The 48-ft. section of pipe, when ready, was rolled on ways from the wharf into the lake, where it floated with about 18 in. out of water. The work of lowering the pipe was necessarily of a delicate nature, as a very trifling distortion would have broken a joint. A section of pipe line was towed between two sets of pontoons, which were made up to form a catamaran.

On this catamaran were placed a hoisting engine and two four-leg A-frames, one at each end, to which was attached a set of four-sheave blocks, equipped with chain

FIG. 2. LAUNCHING WAYS FOR FLOATING 48-FT. SECTIONS OF PIPE LINE

slings leading to each piece of pipe. After the slings were properly attached, the valve was opened and water admitted; and the process of lowering to place began.

As soon as a section of pipe was filled with water, the bulkheads were taken off and towed back to shore, to be used on the next section. A diver, by a code of signals, directed the movement of the pipe, which was accomplished by anchors leading in different directions, so that the catamaran with its load could be moved in any direction and any distance. After the spigot end was entered, it was only necessary for the diver to adjust the spacing clamps and screw up the two 1½-in. bolts that held them.

The pipe was laid to a gradient on three different slopes, the shore end being 12 ft. under water, while at the intake cage it was 60 ft. below the surface. In places the character of the bottom necessitated the use of cradles, which were attached to the pipe before it was sunk; otherwise the entire line was on bottom.

As an indication that the joints were exceedingly ti and the work was thoroughly done, it was noticed th while the diver was working in the pipe, at the out end, air bubbles from his helmet passed through t pipe line from the outer end and escaped into the wa 1200 ft. from the point at which he was working, an did not appear at any other place in the line. This wa satisfactory proof that the joints were all tight.

The intake cage is box-shaped, made up of three sec tions 9-ft. square and bolted together, the top section being provided with vertical rods at 1½ in. c. to c. t prevent any foreign matter larger than ¾ in. entering the intake. Leading from the four corners of the cage are 1-in. cables, about 100 ft. long, to which are attached concrete blocks weighing about two tons each. These ca bles serve as guys to maintain the cage in its vertical position.

FINE AGGREGATE

Snow Guards of Old Crossties have been built by the Boston & Middlesex Street R.R., near Boston, Mass. These are cheap and have proved effective.

Efficiency of Track Gangs at Night was the subject of a question-box symposium in "Aëra," the organ of the American Electric Railway Association, for January, 1917. Out of 14 electric-railway men replying, only one reported night work advisable; this man (H. S. Cooper, Secretary of the Southwestern Gas and Electrical Association, Dallas, Tex.) found results dependent on quality of illumination provided. The general opinion was that 20 to 50% more work could be done in the daytime and that night work should be done only in case of urgent necessity. One company (Lehigh Valley Transit Co.) found greater loss of supplies. Extra wages are generally paid for such night work.

Overtime for Steam-Shovel and Dredge Men—The Reclamation Service has adopted the following rule to form the basis for overtime payments to steam-shovel and dredge men:

Time and one-half for all overtime, except when moving or digging with machine on Sundays or holidays, which shall be paid for at the rate of double time; the following holidays to be observed: New Year's Day, Memorial Day, Fourth of July, Labor Day, Thanksgiving Day and Christmas.

According to the United States "Reclamation Record" for February, this rule applies to enginemen, firemen and cranemen employed on shovels and hydraulic dredges. The rule is to be incorporated in the contracts for employment.

Setting Grade Stakes for Bridge Approach—In grading and repaving the curved and raised approaches to the Cambria St. bridge, Philadelphia, the street surface and curb and gutter heights were first worked out by the help of a contour plan drawn to a scale of ⅛ in. to the foot, with 0.1-ft. contours. To transfer the final design to the ground the method adopted was laying out a system of points on 10-ft. squares, finding the grades of these points by interpolating between contours, and setting and marking stakes accordingly. The labor of setting these stakes was not great, and the resulting pavement surface corresponded more nearly to the predetermined one than could have been obtained by the eye or by the use of level boards.

Suggestion for Binding Engineering Papers—LaVerne J. Ruddock, structural engineer, Wheaton, Ill., uses an inexpensive method of binding his technical periodicals, and passes it on to readers of "Engineering News." He says: "(1) Take the advertising pages off both front and back and remove the staples from all the copies of a volume (half-year, usually). (2) Take two pieces of ⅜-in. board about 3 in. wide and 18 in. long; place one length on the front and the other on the back, allowing a scant ½ in. of the back of the papers to project through. Place a clamp on each end and screw tight. The clamps are small cast-iron bracket clamps obtainable from the hardware store for about 10c. each. (3) With a saw make six or seven cuts into the back of the papers about ⅜ in. deep. Cover the back with glue. (I obtain 'pad paste' from a local job printer.) (4) Draw a string into the cuts made by the saw and lace the back three or four times. Take a strip of cloth and cover the back where the glue has been applied; remove the clamps and boards and allow the glue to dry out for a day or two before use."

Editorials

Water Content in Concrete Must Be Quantitatively Determined

There must be a few men in the concrete industry today who view with mingled resentment and pride the current agitation regarding the proper amount of water for mixing concrete. These men, whose number is not large, are those who for some years past have been trying to urge upon the profession the dangers of overwet concrete and the need for a thorough experimental investigation of the problems of the use of water. Their resentment must be roused by the apparent novelty given the question by those now most concerned in emphasizing it; their pride is naturally due to the recognition of their early efforts, if not of themselves.

But regardless of such personalities there is much that is hopeful in any movement looking toward the rational measurement of water in concrete. To an outsider, for instance, it is most unscientific that we should demand utmost precision in all the factors that go to make concrete and leave one important ingredient to chance or to the inexpert judgment of a mixer foreman. The more we have of such investigations as are reported by Professor Abrams on another page the nearer we will be to perfection in concrete manufacture.

The progress of this question of water in concrete is interesting. There are men still young who remember the day when they stood over the laborer until he rammed the reluctant water to the surface of the concrete. Then came the time when it was only the old fogy who forced this extreme, the "sloppy" mix became triumphant and the water stood ankle deep on every new-laid batch. About then, one rightly regarded as the dean of the engineering profession said in public meeting that he was glad "that the pernicious habit of using dry concrete was fast disappearing." From this extreme the reaction has been slow, but beginning with the Joint Committee's delightful ambiguity that "too much water is as objectionable as too little," the pendulum is on its way back.

What is needed now is some exact criterion of measurement, some simple method by which the proper proportions of mix can be changed from batch to batch, if need be, to produce the optimum result in the finished concrete. It is well enough established that water content is important; the demands now are quantitative, and the laboratory efforts must be toward that end.

The Price of Water Meters

The great increase in the price of water meters has moved the Finance Commission and Mayor of Boston to ask the legislature for a repeal or suspension of the statutory requirement for annually metering 5% of all old services and all new service connections. The inference of the Finance Commission's report, abstracted elsewhere in this issue, is that the present high prices are not justified, and while the report distinctly states that there is no evidence of collusion among the members of the Meter Manufacturers' Exchange, nevertheless it shows that such a possibility was in the mind of the Commission.

Without attempting to pass on the merits of either side of a controversy, which because of local conditions may or may not have much general significance, it is well to remember that there are some obvious and unquestionable reasons for the increasing prices of water meters. Every one is only too familiar with the increased cost of *everything*, since 1915. This is particularly true of brass, bronze, copper, and rubber products, all of which are used in the manufacture of water meters. More than the increase in the cost of these products has been the increase in cost of skilled metal workers, who are in such demand by munition manufacturers.

Moreover, uncertain industrial and market conditions make large bids very hazardous. Proof of this is contained in bids recently opened in Newark, N. J., for water meters. The Union Water Meter Co. bid $8.50 each for 3000 meters of 5/8-in. size, but $9.50 for 5000 meters, bidding the higher price to protect itself against a possible rise in prices during the manufacture of the meters.

In Newark eight bids were received, the lowest being that of the local concern, the Gamon Meter Co., for $7.65 each. This company, it will be noted, is one of the two mentioned in the Boston Finance Commission's report as not being in the Meter Manufacturers' Exchange. The Boston prices, given in the article referred to, include connections.

It is an unfortunate time for meter prices to jump, just when water-works officials have succeeded so well in convincing water boards and legislative bodies that the meter method is the only proper way of selling water. Let it be hoped that the arguments which may justify a temporary suspension of meter installations in Boston will not be used to counteract the good work done elsewhere in helping to put water-works departments on a more business-like basis.

Engineers Would Welcome Better State Government

The Department of Public Domain proposed in the bill before the Minnesota Legislature (*Engineering News* of Feb. 15, p. 293) is a move in the direction of simpler, more responsible and more efficient state government that seems bound to appeal to engineers. Ten or a dozen boards, commissions and offices would be combined into a single department, under a single director. The various functions, some ill defined, would be regrouped under five bureaus each headed by a commissioner responsible to the director of the whole department. Two of these commissioners—Highways and Drainage and Water—would be engineers, and every one of them would have to be "an expert in such matters" as pertain to his bureau, selected without regard to political affiliations.

Another and a more sweeping move in the same right direction has been made in Illinois, where a legislative bill fathered by Governor Lowden provides for consolidating more than a hundred state boards, bureaus and commissions into nine departments, each headed by a director. The proposed Illinois departments are: Finance, Agriculture, Labor, Mines and Minerals, Public Works, Charities and Corrections, Public Health, Trade and Commerce, Registration and Education.

Each of the Illinois directors, like the proposed Director of the Public Domain in Minnesota, would be appointed by the Governor with the approval of the Senate. Each director could therefore be held clearly responsible for the acts or negligence of his department, while the appointing power, in turn, would be responsible to the electorate. It is open to question whether the Governor should not be solely responsible for all administrative appointments, instead of sharing responsibility with the Senate, but perhaps that would be going too fast and far at this stage of American governmental reform.

This proposed state legislation is in direct line with the simplification in municipal government that forms the central feature of the commission plan adopted by half a thousand cities in the last decade, with its sweeping away of numerous uncoördinated and often conflicting boards and commissions and divided responsibility. It is better than the commission plan in that each state department would have a single head instead of many heads.

It is sincerely to be hoped that the Illinois and Minnesota bills, at least in essence, become laws, in order that fair trial may be given to a more simplified and efficient system of state government than is now in vogue. It is high time for the states to fall in line with the cities in the matter of governmental reform.

Increased Steam Distribution in the Streets of New York City

It has been many times predicted by engineers familiar with subsurface conditions in the crowded streets of lower New York, that eventually the commercial distribution of steam through these streets by the New York Steam Co. would have to be abandoned. That there is no present prospect of this prediction coming true is apparent from the fact that a new steam generating station has just been completed by the company, near the East River waterfront on the lower end of Manhattan Island, to take the place of the old Dey St. Station, which was the original plant built by the company. The boiler capacity of Dey St. is about 16,000 hp. The new plant will have 12 boilers, capable of furnishing 24,000 hp.

A surprise in connection with the steam company's business is that a considerable part of the steam distributed is used to develop power. Over 50% of the steam from the downtown station is so used, and more than 20% of the steam distributed from the uptown plant. Other systems of power distribution, which were in extensive use 30 years or more ago—the compressed-air, the hydraulic, and the endless rope systems—have generally been abandoned on account of the superiority of electric-power distribution. The New York Steam Co., however, notwithstanding the heavy conditions encountered in the crowded streets through which its mains pass, continues to expand in business. The importance of the power development side of the business is indicated by the fact that the company proposes to increase the steam pressure in its mains to 125 lb. at an early date, and contemplates eventually raising it to 150 lb.

The company now distributes over 14 mi. of steam mains laid in the streets. Two and a half years ago it was required to replace all its steam mains with new lines thoroughly protected from heat loss by hollow-tile walls, asbestos and mineral-wool covering, as described in *Engineering News*, July 30, 1914.

About 59,000 lin.ft. of street mains had to be rebuilt to conform to these requirements, and about 12,000 lin.ft. of this reconstruction has already been done. The reconstruction is required by the city to protect the other underground pipes and wires in the street from the damage due to the escaping heat from the steam mains. The steam company has been partially compensated, however, for the heavy expense of this installation by the reduction in the amount of heat which it loses between the station and the consumer.

What Is the Matter with Expert Witnesses?

So much dissatisfaction is reported about engineers as expert witnesses that it challenges attention. Some of the complaint is that engineers in court are unable either to help their clients or to illuminate the court on technical questions presented by a case, and that they thereby fail to earn the place in public esteem to which the profession is entitled. The rest of the volume of complaint is that experts employed by public and private interests in utility cases differ in their findings of value for condemnation or ratemaking so widely as to constitute a public scandal. Often both sorts of complaints arise in the same case. Though incidental relations exist in the causes of these typical complaints, the two classes of trouble must be considered separately in an effort to trace their source.

It is, alas, too true that in conspicuously few cases do the knowledge of the engineering expert and the art of the good witness dwell within the same human frame. There are a few engineers, however, who are recognized both for the lucidity of their explanations from the witness chair and their ability to baffle the wiles of the uncandid attorney. But of the practice which these men employ to such ends, all too little has been reported. Herein has existed a definite gap in our engineering literature—a gap which many have found but few have aspired to close. It is a real pleasure therefore to call attention to the unique contribution elsewhere in this issue in which are depicted the peculiar elements which may be conceived as making up the "art of the expert witness"—his realization of his modest place before the court, his confidence in his technical knowledge, his subordination of his efforts to rules of evidence, his care in producing definite impressions on the court, etc. A few men may naturally possess these arts, but obviously others may acquire them to a great degree.

The existence of differences in opinion and finding of facts between the experts on opposing sides of utility cases in most cases is merely indicative of the existence of a controversy. In many cases the differences in finding of facts measure the size of the controversy. The existence of a controversy with two sides presupposes the pos-

ibility of different basic hypotheses laid down by counsel for one side and the other, each capable of more or less creditable support. There can be no great blame cast on engineers for building up different structures of expert testimony when the foundations and materials given them differ as radically as they do.

Yet evidently there is an opportunity for reducing the differences between the opposing experts in valuation cases—in such matters, for instance, as regard the physical facts to be ascertained by duplicate technical inspections, though the differences which thus may be harmonized constitute at present a rather minor trouble in view of the larger discrepancies which arise from the diverging hypotheses of opposing sides.

It is obvious, therefore, that both classes of complaints that we have mentioned may be very largely dissipated. The first variety will disappear with a little more intelligent effort on the part of the engineers who appear in court as expert witnesses. The second variety, if it has any merit in its basis, must be transferred to other shoulders, to the men who direct the procedure of commissions and corporations.

When Doctors Disagree

Th so-called repudiation of the report of the Joint Committee on Concrete and Reinforced Concrete on the floor of the recent convention of the American Concrete Institute was not so radical an act as it has been made to appear in some quarters. What happened was that the meeting, by a vote of 13 to 9, out of certainly 70 members present, voted to pass to letter ballot a building regulation framed by a Commitee of the Institute, which regulation contained numerous provisions at variance with those just adopted in the final report of the Joint Committee, in which the Institute was a participant. A later equally well attended meeting voted 17 to 9 apparently—the procedure was somewhat devious—to accept the regulation but to withhold sending it to letter ballot until next year. At the same meeting the report of the Joint Committee was received but not discussed, as it had not been before the Institute the requisite 30 days prior to the convention.

This was all rather unrepresentative and was obscured by the customary parliamentary wrangles. So far as the floor meetings go they were quite unimportant. The committee reports themselves, on the other hand, are important and it can not be denied that the general situation developed will be confusing. The coming *Proceedings* of the Institute will contain two more-or-less similar reports on the design of reinforced concrete which differ widely on some of the most important details of present-day designing, details on which many are looking for authoritative pronouncements. That neither of these reports will have the acceptance by vote of the entire Institute is immaterial; they both bear the signatures of expert committeemen and will from that fact and from the fact that they are printed have wide circulation and acceptance. The trouble will be that the seeker for authority in design on the disputed points will be helped but little, except as he is benefited by the explanation of some of the provisions the printed discussion will develop or unless he has personal preference for the expert ability of one of the two groups of signers.

The moral of the whole matter is that it is impossible at this early day to lay down exact rules for certain phases of reinforced-concrete design—notably for the design of the girderless floor or flat slab. The hope of some members of the Joint Committee that the debatable questions before them had been settled for some years, at least, is already shown futile. That the dominating members of the Concrete Institute's committee are men engaged in the construction of concrete buildings is important just as it is important that the designer's viewpoint appears to weigh heavy on the Joint Committee, but this very distinction points to some hard sledding for the Joint Committee's report in the future. As this journal pointed out a month ago, an immediate successor to the Joint Committee would not have to pass its time in idleness; there is still work in this field.

Letters to the Editor

Conditions in the Boston Public Works Department

Sir—An editorial and news item relative to conditions in the Boston Public Works Department, the High-Pressure Fire Service and the Fire Department appeared in your issue of Jan. 11. The engineering prestige given the subject by your periodical requires that we correct wrong impressions and misstatements of fact contained in that published statement.

The 17 men whose discharge was referred to were not "fired" by the honorable mayor because they had not been active in reëlecting him, but were dropped by the Commissioner of Public Works because they occupied supervisory positions where their services could be dispensed with to the city's advantage. Thirteen of these men have since been reinstated in the city's service for duties other than those formerly assigned to them. Three whose positions were abolished appealed to the court for reinstatement, and final action is still pending in the Supreme Court. One of these was the division engineer of the Sewer and Water Division, who, under the former commissioner, organized the High-Pressure Fire Service in August, 1911, and subject to the approval of the commissioner was in full control of its activities for 4½ years.

There was selected to have direct charge of the High-Pressure Service an engineering inspector who was in the employ of the National Board of Fire Underwriters, with whom he had had about four years' experience inspecting the water-supply and fire-department equipment of various cities for the purposes of fire protection.

When this selection was made, there were employed in the Public Works Department as engineers with civil-service ratings at least six men who were better fitted by education and experience to handle the problems of high-pressure fire service than the new man. This appointment had a much more harmful "effect upon the morale of the department and the willingness of progressive men to enter its service" than the separation of the division engineer and one other from the Water Service responsibilities.

The engineer in charge of the High-Pressure Service was not dismissed from the department. Just previous to November 20, 1915, after personally investigating the High-Pressure

Fire Service installation, I decided that I would not accept the division engineer's recommendation to certify to the Civil Service Commission that this official was an expert in this work for a further six months' extension of his employment, and he was automatically dropped, not having taken, during his four years' service with the city, any examination under civil service.

The statement that the leakage was raised from the specification requirement of ½ gal. per in.ft. of joint in 24 hr. to 4 gal. or about double that allowed on any similar system, is misleading and untrue. The ½-gal. rate is practically impossible to expect in pipe lines backfilled before testing, as were practically all those installed by the engineer in charge; and the Manhattan high-pressure pipe-laying specifications, dated Jan. 1, 1913, in paragraph 255, state that 4 gal. is the rate allowed, and that this requirement obtained throughout the 127 mi. is confirmed by an article by Max Blatt in the "Journal" of the New England Water-Works Association for December, 1915.

Your reference to my being a politician may be refuted by the fact that, excepting 1½ years, I have been employed continuously by the City of Boston in the engineering branch of its service since 1887 and have qualified through the Massachusetts Civil Service Commission for its highest rating as engineer.

The successful handling of a recent dangerous and threatening fire on Chauncy St. in the heart of the business district by the Fire Department was referred to editorially by the Boston "Globe" and the Boston "Journal" as a sufficient answer to the unjust criticism made by the National Board of Fire Underwriters as to the discipline and efficiency of this department.

The allotted space will not permit me to reply to other misstatements of fact that you have published as extracts from the report of the National Board of Fire Underwriters, some of which were brought to the attention of its chief engineer at a public hearing on the High-Pressure Service recently held in the mayor's office in this city.

E. F. MURPHY,
Commissioner of Public Works.

Boston, Feb. 7, 1917.

[Mr. Murphy's statement of the case of the 17 discharged employees should be supplemented by the facts contained in "Engineering News," Jan. 27, pp. 184, 193, and Feb. 10, p. 291, for the year 1916. The reason why Mayor Curley reinstated 13 of the 17 employees was because such men as Frederic P. Stearns, Desmond FitzGerald, Henry F. Bryant, Charles T. Main, Harrison P. Eddy, Frank A. Barbour and Edward C. Sherman took the lead in publicly denouncing this act as "a disastrous blow, which not only affects most seriously the present efficiency of the department, but will, unless it is counteracted, lower the standard of efficiency to a still greater extent in the future."

It should also be noted that the decision of the City Court in ordering the reinstatement of the other three employees was "that the order of removal was made without proper cause and in bad faith." Their case is now before the Supreme Court of the state, on the mayor's appeal.

The other statements that Mr. Murphy takes exception to are contained in the report of the National Board of Fire Underwriters.—Editor.]

Training Teachers of Engineering

Sir—The article in your issue of Feb. 8, by A. M. Shaw, on "Should Not Engineering Teachers Know How To Teach?" has been read with great interest by the writer, who heartily agrees with Mr. Shaw in many of his statements and especially in his criticism of the ability of engineering teachers.

During the last five years the writer has strongly advocated the elimination of a great deal of the highly specialized instruction that is given at the present time in most of our technical schools. During a four years' course it is only possible to give the student a thorough training in the broad, fundamental principles of pure and applied science. The specialized and advanced work should be left for graduate study. The elimination of many of these specialized courses would provide for the introduction of more work in the important cultural subjects that are necessary for the broad training of the student. With reference to graduate work, the writer ventures to quote from an address which he gave last June before the Society for the Promotion of Engineering Education:

Those technical schools which have the proper resources, teaching staffs and equipment might offer advanced courses in special branches of applied science. These advanced courses could be profitably taken by those students who had attained marked proficiency in their previous scholastic work or by practicing engineers who might desire to secure special training. Advanced degrees could be appropriately awarded for the successful completion of prescribed courses of study.

The writer has often deplored the custom in most technical schools of assigning the younger and less experienced teachers to the freshman and sophomore classes, while the older and abler teachers take charge of the upper-class and graduate instruction. It is self-evident that the freshman class especially needs the attention of the ablest teacher in the department, in order that the students may learn proper habits of study and may acquire a true conception of the character and scope of their future profession and of professional ethics and ideals.

Mr. Shaw's criticism of the lack of training of engineering teachers in pedagogy, education, etc., is largely true. Prof. C. R. Mann, of the University of Chicago, who is making an investigation of engineering education for the Carnegie Foundation for the Advancement of Teaching, stated about a year ago that as a result of a questionnaire which he sent to engineering teachers throughout the country he found that a large proportion of those who replied did not even understand simple educational terms. Most engineering instructors come into the teaching profession directly after graduation or after a somewhat limited practical experience. As regards the selection of teachers to fill the more responsible positions in technical schools, the writer quotes again from the address mentioned above:

How often is an instructor selected because he is a clear, forceful, inspiring teacher? Is not usually more stress laid upon the number of academic degrees or his reputation as a profound scholar or professional expert? The great need of the whole teaching profession today is more teachers of real ability, strong personality and intellectual enthusiasm.

Mr. Shaws suggestion that a post-graduate course for engineering teachers be established is excellent and is one that the writer has had in mind for several years. The following quotation from the above-mentioned address will give a brief idea of the writer's view on this subject:

The speaker believes that there is an opportunity for a few schools to offer an advanced course in engineering instruction. The purpose of such a course would be the training of teachers for our technical schools. The majority of the teachers in these schools today have come directly into the profession from the technical school or from practice and have little knowledge or understanding of the principles of pedagogy and education. The standards of engineering instruction would doubtless be raised if the teachers were required to have a special training which would be comparable to that required for teachers in the highest rank of the common schools of this country.

The writer hopes that Mr. Shaw's paper may lead to a wide discussion of this most important subject of engineering education.

A. B. McDANIEL.

Union University, Schenectady, N. Y., Feb. 9, 1917.

Removing Boric Acid from Volcanic Steam at Lardarelo, Italy

Sir—Referring to your interesting article on the volcano in Italy, which develops 15,000 hp., in "Engineering News" of Dec. 28, allow me to say that I visited Lardarelo, the site of this plant, some years ago and saw the boric-acid works originally established by an ancestor of the present Count.

All of the district now covered by the works was originally owned by the people of the neighboring ancient town of Monte Cerboli, but having been held by them as of little value, it was very cheaply obtained in 1818 by a poor young Frenchman (grandfather of the present Count Lardarelo), who detected the presence of boric acid in the steam and who was shrewd enough to appreciate the value of his discovery.

The boric acid to the extent of 0.1% is contained in the native steam that issues from the earth through numerous orifices, all of which have been tubed to a greater or less degree. These tubings are mostly of 8-in. pipe, and extend into the earth varying distances, some a few feet and others over three hundred. Certain of the fumaroles are entirely artificial, having been bored like artesian wells. The boring tool, when it reaches the steam zone, usually drops suddenly a yard or more, and immediately thereafter steam escapes with much force. The temperature of the issuing steam varies in the different outlets from 98 to 140° C., and it rushes from the pipes with great noise and power.

Ordinary spring water is led into a circular brick cistern about 30 ft. in diameter, and an 8-in. pipe, conducting natural steam, passes through the cistern wall about 1 ft. below the water surface. The issuing steam impregnates the water with boric acid.

After 24 hr. the solution is delivered to a square settling basin, where a grayish mud composed of exceedingly fine particles is precipitated, and the clear boric-acid water passes to lead evaporating pans (40 in number). These pans are 6 ft. wide by 150 ft. long by 8 in. deep. They are slightly inclined and are divided by small ridges 2½ in. high crossing them

transversely every 2 ft. The liquid enters at one end and slowly flows over the step-like divisions to the other, the rate of inflow being made equal to that of evaporation.

When in the judgment of the attendant the concentration has been carried far enough the flow is cut off and the hot, concentrated liquor is brushed out by brooms into crystallizing tanks, 10x30 ft. in size, and allowed to cool.

The deposited crystals of boric acid are removed by wooden scoops, drained in baskets, and the mother liquor is returned to the evaporating pans. The crystals are spread upon a steam-heated drying floor protected by a shed-like building 30x40 ft. in plan, and when dry are placed in bins for storage. The heating of the evaporating pans and drying floor—in short, heating of every description throughout the establishment—is by native steam.

The statement in our standard works of reference that "boric acid is recovered at both Monte Cerboli and at Lardarello" is confusing, as they are practically one and the same place; and the dimensions given the artificial lagoons, "100 to 200 ft. in diameter," is a great exaggeration.

W. P. MASON.

Department of Chemistry, Rensselaer Polytechnic Institute, Troy, N. Y., Jan. 26, 1917.

Flood Gates in Levees

Sir—I notice in your issue of Jan. 11, in an article on a "Large Levee and Drainage System in Indiana," a paragraph indicating that flood gates will now be installed, with perhaps a pumping plant later. Some information concerning any system where flood gates have been successfully used for a length of time under trying conditions would be very interesting.

F. E. STAEBNER.

Fort Pierce, Fla., Jan. 20, 1917.

[This inquiry was referred to J. S. Spiker, engineer of the drainage system referred to, and he replies as follows.—Editor.]

Sir—Automatic flood gates such as we are using on the Brevoort levee have been in successful operation on the Wabash River at and near Vincennes for more than 30 years. My experience does not extend to any other stream. I have used them from 1 to 6½ ft. in diameter, but would not advise the use of gates more than 5½ ft. in diameter. When these circular flap gates are too large, they need as much attention as rectangular lift gates; and I make the division at 5½ ft.

The local conditions should govern the size that will work successfully, and great care should be exercised in placing the gate. It should be above the level of the accumulation of silt or fill near or at the gate, and also clear of débris or other light or floating matter that might accumulate in the culvert behind the gate. Two gates of the same size at different locations will vary in operation. We have practically closed in all the Brevoort levee work. The large flood opening at River Dushee is ready for the placing of the operating machinery.

J. S. SPIKER,
Consulting Civil and Sanitary Engineer.

Vincennes, Ind., Feb. 2, 1917.

Percolation Tests of Sewer Pipe

Sir—Permit me to answer the inquiry of G. E. P. Smith, as to the necessity of a percolation test of sewer pipe.

The percolation test for sewer pipe was, I believe, first used in Brooklyn, N. Y., for the reason that much of Brooklyn's sewage is pumped and any extra water to be handled by the pumps adds materially to the cost of operation. Many miles of this city's sewers are below ground-water level.

Kansas City, as a safety measure, copied this clause out of the Brooklyn specifications, although the topography of the city was not similar. The reason it is not used in Kansas City is because the specifications require an internal hydrostatic pressure test on both clay and cement pipe, and it was found that any pipe withstanding the pressure test would also stand the percolation test.

The difficulty with the percolation test is that it is not always specified in accordance with the use to which the pipe is to be put. There is little use in specifying a percolation test under high pressure unless the pipe is expected to work under pressure. It would be much more practical and more logical to substitute a density or porosity test. The American Society for Testing Materials has already acted along this line, and its latest specifications for drain tile (sewer specifications still incomplete) are designed, not to discover under what pressure the pipe will begin to leak, but what proportion of the pipe is voids, which is the important point.

The British Engineering Standards Committee previously reached similar conclusions and prescribed an absorption test for vitrified-clay pipe.

Besides the absorption test the American Society for Testing Materials prescribes loading tests, chemical tests, freezing and thawing tests, but all these are written so as to meet, as nearly as possible, actual conditions of service. City engineers would therefore seem justified in recognizing the three principal reasons why sewer pipe should be as much pipe and as little holes as possible—namely, the sanitary reasons, the economic reasons and the structural reasons. The only error seems to be in copying, blindfold, the specifications from one city written to meet a special condition that does not exist in the others.

BENJAMIN BROOKS,
Engineer, International Clay Products Bureau.

Kansas City, Mo., Feb. 6, 1917.

[The Brooklyn specifications, according to Edwin J. Fort, Chief Engineer of the Bureau of Sewers, are rigidly enforced, whenever the sewers are placed below groundwater level. The clauses covering these percolation tests and the regular absorption test are:

170. When subjected to an internal hydrostatic pressure of 10 lb. per sq.in. vitrified pipe shall show no percolation.

171. After having been thoroughly dried and then immersed in water for 24 hr., sample pieces of vitrified pipe about 10 sq.in. superficial area with all broken edges shall not absorb more than 5½% of their weight of water.—Editor.]

Is Compression Positive or Negative?

Sir—Permit me to join R. W. Stewart ("Engineering News," Feb. 8, p. 248) in asking for some solution of the problem involving plus or minus marks for compression. This point, while a small one, causes considerable confusion in engineering offices and will continue to do so until it is settled. Kidder, Ketchum and the Carnegie "Handbook," as well as other standard works, use plus for compression and minus for tension. As you say in comment, all draftsmen of 20 years ago used the same system. The use of a minus sign for compression is a present-day practice.

Personally I favor + for compression; wall pressure is +, and the change of material from brick to steel should not change the sign. The best argument in favor of the minus sign is that, used thus, it agrees with Hooke's law of deformation, which law plays a very small part in the great majority of structural designs. If any of the national engineering societies—preferably the American Society of Civil Engineers—would give this matter a half-hour's attention, I believe that engineers and schools would accept the verdict.

P. B. MACCOY.

Pittsburgh, Penn., Feb. 13, 1917.

NOTES AND QUERIES

Herbert C. Hoover—In the article on the work of Herbert C. Hoover, Chairman of the Belgian Relief Commission, in "Engineering News" of Feb. 1, it was stated that Mr. Hoover was a graduate in mining engineering from the University of California. Mr. George H. Herrold, of St. Paul, a classmate of Mr. Hoover's, informs us that Mr. Hoover graduated from Leland Stanford Jr. University, and his course of study was geology, as the university had at that time no course in mining engineering.

Cleaning Cement Wash from Brick—J. W. B., who is in charge of the construction of a power house, writes to inquire the best method of cleaning cement mortar off the upper part of the walls. These walls are faced with a tapestry brick made with mortar consisting of one part portland cement, one part hydrated lime and four parts river sand. The roof is of concrete, and heavy rains occurring just as the roof was completed washed a film of cement off the roof onto the upper part of the walls, considerably disfiguring them. Of several methods suggested for cleaning these walls, it is felt that wire brushes require a great amount of labor and might not be effective and that an acid wash might injure the walls. Has anyone had successful experience in doing work of this sort?

New York Garbage-Reduction Works Controversy—By an omission in copying at Albany, the last clause of the third finding of Deputy State Health Commissioner Linsly E. Williams in the matter of the location of garbage-reduction works for New York City on Staten Island was omitted in the report to Governor Whitman (see "Engineering News," Jan. 18, 1917, p. 125). The third finding, as stated in a revised copy filed with Governor Whitman, was as follows:

The operation of the proposed plant will disseminate objectionable odors at times and under certain atmospheric and operative conditions in the neighborhood of the proposed plant, including the Village of Linoleumville, the settlement known as Fresh Kills and other property located in that vicinity, and will thereby constitute a nuisance.

Effect of Excess Water in Concrete*

By Duff A. Abrams†

Experience has indicated about what proportions of cement and aggregate must be used to give concrete of the necessary resistance for a given purpose, but little attention has been given to the inter-relation of the effects of varying quantities of water on the resistance of the concrete. A thorough investigation of this subject is in progress at the Structural Materials Research Laboratory. These tests have shown the following relations to obtain:

1. With a certain aggregate of the same grading and sufficient water to produce a concrete of a given plasticity, the strength of the concrete, within the usual range of mixes, is proportional to the quantity of cement in a unit volume of concrete.

2. With a given aggregate and the same quantity of cement, the strength of the concrete is a maximum with the smallest quantity of water which can be used to produce a plastic mix; any increase in the quantity of water is accompanied by a very rapid falling off in the strength of the concrete.

3. With a given aggregate mixture, the same quantity of cement, and sufficient water to produce a concrete of definite plasticity, (a) the strength of the concrete increases with the "coarseness" of the aggregate up to a certain limit; (b) this limit of "coarseness" is higher for a larger quantity of cement and lower for a smaller quantity of cement; (c) the limit of "coarseness" of the aggregate which it is feasible to use varies slightly with the character of the material, being somewhat lower for a mixture of sand and crushed stone than for sand and well-rounded pebbles, and lower still for mixtures in which crushed stone or similar material is used as fine aggregate.

4. For given proportions of cement and aggregate the quantity of water required for a definite plasticity depends largely on the grading of the aggregate and to only a minor degree on the character of the material, shape of particles, etc.

5. For a given aggregate, the quantity of water required to give concrete of the same relative plasticity is directly proportional to the quantity of cement.

The tendency has been during recent years to use entirely too much water; in many instances the water used is 50 to 100% in excess of the quantity which gives the highest strength, resulting in concrete of not more than 25 to 50% the strength that should have been obtained with the same cement and aggregate and a proper quantity of water. While some sacrifice in strength is generally necessary in order to secure concrete which may be handled and placed at low cost, it is absurd to sacrifice 50 to 75% of the strength which is practically available in this way. While the injurious effect of excess water in concrete has been given little attention, a great deal of emphasis has been placed on the benefits to be derived from the use of coarse, well-graded aggregate.

The experimental work referred to above has already thrown much new light on this subject. We are forced to the conclusion that the chief advantages of well-graded and coarse aggregate as compared with poorly-graded aggregate comes from the fact that the concrete can be mixed to a workable plasticity with less water, and not to any inherent difference in the behavior of aggregate of different sizes. In other words, while coarse, well-graded aggregate is highly desirable, little or nothing is gained by using aggregates of the highest grade unless we take advantage of the fact that it can be mixed with correspondingly less water. This makes it apparent that many of the shortcomings of concrete made of fine or poorly-graded aggregate should be charged to the additional water required to mix the concrete.

It is as important that an upper limit be placed on the quantity of water as it is that a lower limit be placed on the quantity of cement in the batch. It would be just as consistent to specify the quantity of aggregate and water and leave the proportioning of the cement to the judgment of the mixer foreman, as to specify the quantity of cement and aggregate and leave the proportioning of the water to the mixer gang. Exactly the same effect is produced by the use of an excess of water as by a deficiency in cement; and it is more important now that special attention be given to the water in concrete, since the present methods give reasonable assurance that the proper quantity of cement is used.

All the benefits which may arise from using good cement, coarse, well-graded aggregates, thoroughly mixing the concrete, etc., are completely nullified if an excess of water is used in the mix.

"In mixing concrete use the least quantity of water that will produce a workable mix, then give the concrete as much water as possible after it has begun to harden," is the only safe rule to follow.

Probably the greatest improvement which can be made in our present methods of manufacturing concrete will come from a better understanding of the very injurious effect of excess water and a saner practice in proportioning this important element of the mix.

*From "Concrete Highway Magazine," January, 1917.

†Professor in Charge Structural Materials Research Laboratory, Lewis Institute, Chicago.

Concrete Pipe and Tile

The use of concrete sewer-pipe and drain-tile was discussed from different points of view at the annual meeting of the American Concrete Pipe Association, held at Chicago, Feb. 12-14. The new specifications of the American Society for Testing Materials were reviewed by Geo. P. Diekmann (Chief Chemist of the Northwestern States Portland Cement Co.), and his remarks developed considerable discussion, particularly as to the proper requirements for the absorption test. A special field for concrete drain-tile, apart from its direct competition with clay tile, was suggested by E. R. Woods, State Drainage Engineer of Wisconsin. Transportation from rail to site is a large item in cost, and there are many districts which need drainage but where a haul of 10 to 15 mi. would be involved. He suggested the design of small concrete-pipe plants which could be located in such districts for two or three years and then shifted to other districts. Further, he considered 5-in. pipe should be the minimum size, to the exclusion of the 4-in. pipe now used.

Tests of the supporting power of pipe in trenches were reviewed in a paper by W. J. Schlick (Iowa State College). The use of a light concrete bed appears to offer many advantages. It was pointed out that it is not safe to rely upon arching of the earth fill to relieve the load upon the pipe, as saturation may prevent any such arching. The use of large tile drains as a substitute for open ditches was discussed by C. D. Kinsman (Purdue University). The tile drains avoid the division of land by ditches, and it is thought that they will keep in better condition, while the cost of maintenance will be much lower. Tile as large as 36 in. is being used. Mr. Kinsman considered that this line of work is in its infancy and offers a large field for development.

G. F. Lillie (Platte Valley Cement Tile Co.), Fremont, Neb., was elected President.

News of the Engineering World

Work Started on New Double-Deck Bridge in Kansas City

Work has begun on the new Kansas City Terminal Railway bridge over the Kansas River and the High Line viaduct which was noted in *Engineering News* for Oct. 26, 1916, as one of the improvements contemplated in the 200-year franchise recently granted the Terminal Company by Kansas City, Kansas.

The bridge itself will be built on the two existing piers, originally designed for a two-track structure. A new west abutment will be constructed. The present single-track steel bridge, built on the south side of the piers, was moved last spring to the center of the piers and raised so that the new bridge can be erected around it without interfering with traffic. The new bridge will be a double-deck structure, with two tracks on each deck. It will have two 300-ft. truss spans 65 ft. deep between pins and one 132-ft. truss span 30 ft. deep. The trusses will be 32.5 ft. apart c. to c., providing a clearance of 28.5 ft. for the double track. The clearance from top of rail for each deck will be 23 ft. The end posts and top chord will be of high-carbon steel and the eye-bars of nickel steel, the balance of standard structural steel. The floors will be timbered and ballasted for the track.

The trusses were designed by the Terminal Company's own forces, George E. Tebbetts being Bridge Engineer and John V. Hanna, Chief Engineer. Cooper's E80 loading was used, allowing unit stresses 25% in excess of those usually allowed. Under this method, while the bridge may be considered as designed for Cooper's E60 and normal unit stresses, any future increase in loading will find the details and connections equally as strong or with as large a factor of safety as the members themselves. On account of the ballasted floor, only 75% of the regular impact formula was used.

The upper deck of the bridge will be connected with the new double track High Line viaduct. This will extend to the east approximately 2700 ft. and with 1000 ft. approach between concrete retaining walls. On the west end, the viaduct will branch about 2075 ft. from the bridge, one branch extending north 7100 ft. and with 2000 ft. of approach between concrete retaining walls, the other due west 6500 ft. The viaduct will be the ordinary deck girder double-track construction except for three truss spans over railroad tracks of 117, 135, and 147 ft. span. The girders will have spans of from 50 to 60 ft. and all the steel portion of the High Line will have a concrete floor and ballasted track. The total length of the steel viaduct will be about 7700 ft. and there will be 12,000 ft. of graded approaches (a large part of which will be between concrete retaining walls) to connect with the surface main lines. The east approach will end close to the Union Station in Kansas City, Mo. The north branch of the west approach will end about 2200 ft. north of Central Ave.; the west branch of the west approach will end about Twelfth St. The High Line will therefore be used primarily for passenger train traffic, which will be taken up out of the congested switching and industrial track traffic, while the lower deck of the Kaw bridge will be used by freight traffic.

The Arkansas Bridge Company, of Kansas City, has been awarded the contract for the steelwork, and D. Munro & Co. the contract for a large portion of the concrete work. The whole improvement will cost close to $3,000,000. It will require nearly two years to complete.

Government Cement Specification

The United States Government has adopted for its standard specification for portland cement one in substantial accord with that adopted in 1916 by the American Society for Testing Materials, but varying from that specification in one important particular. The so-called "standard" specification has the following provision for fineness:

> The residue on a standard No. 200 sieve shall not exceed 22% by weight.

As a footnote to this clause the new government specification states that effective July 1, 1918, the government will demand a 20% residue requirement through the No. 200 sieve.

Boston Water Meter Controversy

The Mayor of Boston has decided to adopt the recommendations of the Boston Finance Commission to petition the legislature for a suspension of that provision of the laws creating the Metropolitan Water District, which requires the annual installation of meters on 5% of all old services and on all new services. In this connection the report of the Finance Commission states:

> It is the consensus of opinion among engineers that the essential object to be gained by water meters in the City of Boston has already been secured. The more important services have been metered and the meters in future will be installed in suburban districts where the use of water is below the average.
>
> There is ample expert authority for the prediction that the daily consumption of water per capita in the City of Boston will not fall below 100 gal. per capita. The consumption for 1915 appears to have been 104 gal. per capita. It is probable that any reduction per capita in water consumption in the future will be due to increased congestion of population, weather conditions, better pipe laying as regards the mains, the prevention of waste at faucets, and similar causes, rather than from the use of meters.
>
> The Finance Commission believes that at the present time a sufficient saving will not be made by the installation of meters at the prices demanded by the manufacturers to be commensurate with the expense involved.

The Finance Commission report also criticises the Supply Department of the city for not purchasing more meters while prices were low, although a provision of the city charter and a provision of the state law already referred to would seem to prohibit the purchase of more meters in any one year than the number to be installed during the year. It is recommended that the legislature be petitioned to repeal this provision.

A brief record of the rise in meter prices in Boston follows: From 1911 to 1914, inclusive, the Hersey Manufacturing Co. was awarded contracts for 5/8-in. meters at $5 each. In 1915 Henry R. Worthington received the contract at $4.95. In 1916 bids were opened on Mar. 6 for 5500 meters, 5/8-in. size, with an option of increasing or reducing the quantity by 30%. The prices were: Hersey Manufacturing Co., $5.55; Henry R. Worthington, $5.90; Thomson Meter Co., $8.40 and the Pittsburgh Meter Co., $6.66. The only bid for the 1917 supply—5500 meters of 5/8-in. size—opened Dec. 26, 1916, was that of the Hersey Manufacturing Co. of $8.40. This bid was rejected and new bids were asked, which were opened Jan. 9, 1917. These bids were: Hersey Manufacturing Co., $8.40; Union Water Meter Co., $8.40; Thomson Meter Co., $8.60; Buffalo Meter Co., $9.40; Pittsburgh Meter Co., $11.50. These bids have also been rejected.

In investigating this increase of prices, the Finance Commission interviewed James A. Tilden, General Manager of the Hersey Manufacturing Co., and reports as follows:

> There has been formed, with headquarters in the City of New York, the Meter Manufacturers' Exchange, comprising eight of the ten companies manufacturing water meters in the United States. The Gamon Meter Co., of Newark, N. J., and the Badger Meter Co., of Milwaukee, Wis., are the two companies which are not members of the exchange. Mr. Tilden stated that he is the president and that there is a permanent secretary.
>
> The Commission has no evidence that the Meter Manufacturers' Association is used as an opportunity for water meter manufacturers to raise prices by collusion in their bidding, or that such acts have been attempted. It does believe, however, that associations of this kind offer an excellent means for such collusion and their existence is a potential danger to open competition.

Jersey City Water-Supply Contest Suit May Be Reopened

What promises to be a most interesting occurrence in the litigation branch of water-supply and sewage-pollution sanitation is the recent determination of the City Commission of Jersey City to open up the old suit brought by that municipality against the Jersey City Water-Supply Co. to compel the latter to construct a trunk sewer to divert the sewage of Dover, Boonton and other municipalities below the Boonton dam and reservoir of the Jersey City water-supply.

When Jersey City contracted some years ago for a new gravity water-supply from the Rockaway River, there was inserted in the contract a provision that the contractor must deliver pure and wholesome water. Rightly or wrongly, the people both of Jersey City and in the Rockaway River drainage area above the site of the proposed dam got the idea that the contractor would build a trunk sewer to carry the sewage of the various municipalities along the course of the river to a point below the proposed reservoir. Instead of doing this, the Jersey City Water-Supply Co. installed the first large hypochlorite disinfection plant, and one of the very earliest of the kind large or small, at the Boonton dam, claiming that this plant fulfilled the contract requirements as to providing pure and wholesome water. A battle royal in the courts followed, with the result that the contractor won the suit. The court held on the strength of the evidence submitted that hypochlorite disinfection of water was a sufficient safeguard to fulfill the contract requirements mentioned. The testimony and decision, it should be noted for the benefit of those not informed, was handed down very early in the history of hypochlorite disinfection.

After the decision was rendered, there were negotiations between Jersey City and the municipalities in the Rockaway River drainage area looking to the construction of a trunk sewer at joint expense. A consummation of these negotiations seems to have been prevented by unwillingness on the part of one or more of the municipalities on the drainage area. Subsequently, Jersey City changed to the commission form of government. After numerous conferences between the representatives of Jersey City, the municipalities in the drainage area and the State Department of Health, it was finally made clear that Jersey City was determined not to pay any part of the cost of a trunk sewer and was trying to get the State Department of Health to force the municipalities in the drainage area to bear the whole responsibility and expense of any measure necessary to protect the water-supply.

When this became evident the State Department of Health forthwith notified the authorities of Jersey City to show cause why they should not be directed to prepare plans and submit them within two months for an uptodate water-purification plant. About the same time Dover submitted to the State Department of Health plans for a sewage-treatment plant, the effluent from which would be discharged into the Rockaway River above the Boonton reservoir. A sharp division of opinion arose in the State Department of Health as to the various questions involved in the Jersey City water-supply situation. An attempt was made to secure the adoption of a general policy that would serve as a guide not only in this but in other cases throughout the state involving relations between sewage pollution and public water-supplies. It does not appear that the department has ever taken final action in the matter.

The latest reported move along any definite line is the action of the Jersey City Commission already mentioned. Under the terms of this action Corporation Counsel John Milton will apply for a reopening of the old lawsuit against the Jersey City Water-Supply Co. on the ground that the court was misled (although not wilfully) into the belief that hypochlorite disinfection was an adequate substitute for the diversion of the sewage of the various municipalities to a point below the reservoir.

Finally, it may be noted that all the municipalities in the Rockaway drainage area above the Boonton dam are as yet practically without sewerage systems, so that such pollution as is reaching the water-supply comes for the most part from individual buildings.

Fire in Flooring of McKinley Bridge

Fire was discovered in the wood flooring of the McKinley Bridge of the Illinois Traction Co., over the Mississippi River at St. Louis, at 6 p.m. on Feb. 15. This bridge was built principally for interurban car service, in 1910, and once before its flooring was on fire.

The bridge is a single-deck structure, carrying double tracks between the trusses, and has a roadway about 12 ft. wide cantilevered on each side. The cantilever construction consists of brackets at the main panel-points, which are joined longitudinally at the outer and inner edges by light steel girders. These girders in turn carry a light

steel floorbeam at the center point, thus reducing the spacing to about 15 ft.

The floor construction consists of five 8x16-in. timber stringers, one end resting on the bracket and the other on the center beam. The floor itself is made up of slats 1x2½ in. by 4 ft. long joined together to form sections 20 in. wide by 4 ft. long by 3½ in. deep, and held together by three bolts running through the 20-in. width. As laid in the bridge there are three sections to the width of the roadway, so that each section rests on three stringers. The stringers are creosoted yellow pine, while the floor slats are of mixed hardwoods, largely oak. The floor slats are untreated but seem to have been dipped in pitch or some preservative before laying. The wear on the floor has been very severe and it is estimated that probably all of it has been replaced at least once since the bridge was opened. At the present time, much of it is badly broken and crevices between the slats are filled by dry manure and fine dust.

The origin of the fire is unknown, but is supposed to have been due to a live coal dropped from a tar-roofers' wagon; although the fire was practically confined under the floor, it is impossible that it could have been ignited from underneath.

Several hundred feet of the north roadway was affected by the fire, much of the flooring being ruined and a large proportion of the timber stringers badly charred, particularly at the ends. In addition to this, the two longitudinal steel girders at the edges of the roadway were overheated. Many of them are warped and several broken through. There seems to be little damage to the cantilever brackets and none to the main trusses. The total damage will probably not exceed $15,000.

The American Association of Engineers Meets Membership Problem

The young and radical American Association of Engineers has begun to face the problem of qualifications for membership like the old-established societies. Where the qualifications approach the minimum of the requirements, it is found to be a difficult matter to pass judgment on the individual cases. At the recent Chicago convention N. M. Stineman (Office Engineer, Chicago, Milwaukee & St. Paul Ry.), who is chairman of the committee on qualifications, discussed the subject in detail.

The constitution of the association states that a certified member shall be a graduate of an engineering school of good standing, and in addition he shall have had two years of engineering experience. The committee took the position that "engineering experience means nothing less than the solving of engineering problems." Tracers and rodmen, for instance, are not called upon to solve engineering problems; consequently, their work cannot be classed as experience in engineering.

Applicants who have not graduated from technical schools may be admitted to certified membership after they have had at least five years of experience in engineering.

Again, what is meant by experience? Taking as his example the case of a young man who enters an engineering office and spends perhaps several years in tracing, Mr. Stineman holds that this apprenticeship portion of his work cannot be classed as experience in engineering. What weight should be given to school training of various kinds is another question that has given trouble. The committee answers him as follows:

> The committee finds it extremely difficult to give proper weight to the education of many of the applicants. If the membership were confined to graduates of technical schools, the work would be greatly simplified, for it would then be provided with a definite starting point. However, many men obtain an engineering education through special or partial courses in engineering institutions, through technical high schools, night schools and correspondence schools. The committee wishes to give recognition to men who by their persistency and native ability have succeeded in getting a technical training through some such manner, but such recognition should not be carried to the point of absurdity.
>
> We should not lose sight of the worthiness of many men who, with no financial resources aside from their own savings, have denied themselves everything else in order to win a thorough college training. Surely they are quite as worthy of our consideration as are the men who have taken a shorter, easier and less thorough road to engineering. Consequently, an applicant who has spent but a few months in an engineering institution will not be considered as having completed a "partial course" in that institution; not all so-called technical high schools are such in reality; night-school work cannot be recognized unless the studies were pursued through a considerable length of time; and uncompleted courses in correspondence schools cannot be considered.
>
> Recognizing the obvious fact that a minimum educational qualification must be established somewhere, the committee will not grant membership of any grade to a man who is not a technical graduate, unless he is a graduate of a high school or of an academy or other school with a course of study similar and equal to that of a high school.

Licensing Architects in Indiana by means of a State Board of Architects has been defeated, 51 to 36, in the lower house of the Legislature.

Building in Canada was much more active in 1916 than in 1915, which was a very slack year. The new structures are partly due to demands of war industries and partly to the establishment of Canadian branches of American manufacturing corporations.

Ten Coal Cars and an Engine Were Seized on the Pennsylvania R.R. in Cleveland, Ohio, on Feb. 10, by a police squad under the direction of T. S. Farrell, Director of Public Utilities. The municipal water and electric stations had only a few days' supply and the City could not secure deliveries of its own fuel.

Teamsters Must Inspect Bridges in Kansas—A teamster whose wagon broke through a bridge floor in Kansas sued for damages, but when his case came to trial, recently, it was thrown out of court. An old Kansas law provides that when a teamster with a heavy load reaches a bridge he must examine it before driving on it, and if necessary lay planks for his wheels. This teamster had failed to follow the law.

Further Progress on the East River Tunnels was recorded by completion of the headings in the Brooklyn approach to the Whitehall-Montague St. tunnel. The south tunnel was holed through to the shaft at Clinton and Montague St. on Jan. 30, and the north tunnel a few days later. These land tunnels were started at Willoughby St. and Flatbush Ave. Extension on Mar. 10, 1915. Shields were used, without compressed air, the sand being dry.

A Steamship and Warehouse Terminal in the southern part of San Francisco is planned by the Southern Pacific Co. It is proposed to widen the Islais Creek channel to 300 ft. and deepen it to accommodate vessels of 35-ft. draft. Warehouses would be constructed adjacent to the slip, and the total investment contemplated is about $10,000,000. Plans for the work have been made by Howard C. Holmes, Chief Engineer of the San Francisco Dry Dock Co.

Electrification of the Lehigh Valley R.R. is under consideration, and engineers are now making surveys and investigations preparatory to rendering a report upon the project. The Lehigh Valley carries a very heavy coal traffic from the anthracite region to tidewater, and all trains have to climb over a high summit in passing west from Wilkes-Barre. It is stated that the plans for electrification comprehend the entire main line from Jersey City to Wilkes-Barre.

A Broken Water Main in Brookline, Mass., tore up a sidewalk, blocked electric cars and flooded cellars on Feb. 14, at 6:45 a.m. The main, 30 in. in diameter, was laid by the City of Boston in 1848 and carried a normal pressure of 44 lb. per sq.in. The street covering was asphalt on a concrete base and was strong enough to force the water to one side, where it

broke through the brick sidewalk. A sewer was recently laid under the sidewalk, not many feet from the water main, and W. E. Foss, Chief Engineer of the Metropolitan Water Board, stated that possibly the main broke because of ground subsidence.

The February Blizzards in Wyoming are the worst in many years, according to press dispatches. The experience of one of the trains (Overland Limited) of the Union Pacific R.R. is detailed. The train left Laramie behind a rotary snowplow pushed by five locomotives, but was nevertheless stalled at Rock River. The snowdrifts were bucked until the plow was broken. Thirteen trains were in line at Rock River at one time on the westbound track, while about 15 eastbound trains were held up in the vicinity. When the train was first stalled, the temperature was 47° below zero, unofficial reports state. The Overland Limited reached San Francisco 79 hr. late.

A City-Manager Charter for Kansas City, Mo., will go to popular vote on Mar. 6. An administrative board of ten members and mayor, elected at large, would fix the general policy of the city and appoint a city manager who would, in turn, appoint the heads of the various departments and conduct the business affairs of the city. The proposed charter provides for the initiative, referendum and recall on moderate petition percentages. It also simplifies public improvement proceedings, provides for payment of contractors in cash and reduces the interest on tax bills from 7 to 6%. The engineer plays a prominent part throughout, the city engineer being deputy city manager. A campaign has been inaugurated and meetings of information are being held.

PERSONALS

C. M. Thompson has been appointed Division Engineer of the Union Pacific R.R. at Denver, Colo.

Joseph F. McGuire, County Surveyor of Johnson County, Missouri, has been appointed County Highway Engineer.

F. L. Manning has been made General Manager of the Peebles Paving Brick Co., Portsmouth, Ohio, succeeding S. C. Peebles, resigned.

George Smart, Editor of the "Iron Trade Review," Cleveland, Ohio, has resigned to join the editorial staff of the "Iron Age," New York City.

Leo J. Byrne, County Surveyor of Meigs County, Ohio, has been appointed City Engineer of Pomeroy, Ohio, succeeding E. G. Campbell, resigned.

C. M. Garland has been placed in charge of the new power department of the Allen & Garcia Co., consulting and constructing engineers, Chicago.

Alva O. Greist announces that he has opened offices at 51 East 42d St., New York City, as Consulting Engineer, specializing in public utility properties.

Edward W. Dahl, formerly County Engineer of Yuma County, Arizona, has been appointed City Engineer of Yuma, Ariz., succeeding W. H. Elliott, resigned.

R. S. Durrell has resigned as Assistant Engineer of the Ohio State Board of Health, Columbus, Ohio, to accept a position with the Sewer Pipe Manufacturers' Association, Akron, Ohio.

W. H. Wood has been appointed County Highway Engineer of Vernon County, Missouri, at an annual salary of $1000 per annum. He is also County Surveyor, which is an elective office.

H. De H. Connick, M. Am. Soc. C. E., former Director of Works of the Panama-Pacific Exposition, San Francisco, Calif., is now with the American International Corporation, New York City.

D. C. Moon, General Manager of the New York Central Lines West of Buffalo, has been appointed Assistant to the Vice-President in charge of operation. His headquarters for the present will remain at Cleveland, Ohio.

C. E. Johnston, M. Am. Soc. C. E., Chief Engineer of the Kansas City Southern Ry., has been promoted to be General Manager. This is a new position, the duties of which have hitherto been divided among the vice-presidents.

C. Gore-Langton, recently Designing Draftsman, Chief Engineer's office, Atchison, Topeka & Santa Fe Ry., Western Lines, Amarillo, Tex., is now in charge of design and erection of a new unit of the Natural Soda Products Co., Keeler, Calif.

Walter Braun, County Engineer, **Joseph H. Fleming** and **E. P. Knollman,** of the County Engineer's office, Franklin County, Columbus, Ohio, have formed the engineering and surveying firm of Braun, Fleming & Knollman, with offices in Columbus.

W. A. Williams, M. Am. Inst. M. E., Chief Petroleum Engineer, United States Bureau of Mines, with headquarters San Francisco, Calif., has resigned to become Assistant to General Manager of the Empire Fuel & Gas Co., Bartlesville, Okla.

Raymond Matthew, for the past year head of the Department of Irrigating Engineering, New Mexico College of Agriculture and Mechanic Arts, has resigned to become Assistant Engineer for Charles H. Lee, Consulting Engineer, Los Angeles, Calif.

W. A. Hey, formerly of the Miller-Hey Co., contractors, Waterloo, Iowa, and **B. H. Keeler,** for the past 10 years superintendent and Chief Engineer of the Crane Construction Co., Kansas City, Mo., have organized the Hey-Keeler Construction Co., Black Hawk Bldg., Waterloo, Iowa.

Dwight D. Miller has joined the staff of the Society for Electrical Development, New York City. He is a graduate of Harvard University. He was for over ten years with the Westinghouse Electric and Manufacturing Co. as Sales Engineer. He has been Sales Manager and Consulting Engineer for two other firms handling electrical and mechanical apparatus.

A. S. Ingalls, Assistant General Manager of the New York Central Lines West of Buffalo, has been promoted to be General Manager, succeeding D. C. Moon, promoted, as noted elsewhere. Mr. Ingalls is a graduate of Harvard University and entered the railway service as a clerk in the office of the General Manager of the Cleveland, Cincinnati, Chicago & St. Louis R.R.

Erle T. King, Assoc. M. Am. Soc. C. E., recently Assistant Engineer with Lederle and Provost, Consulting Sanitary Engineers, New York City, and for 10 years Assistant Engineer with the Board of Water Supply of the City of New York on Catskill Aqueduct work, has been appointed Assistant Secretary of the General Contractors' Association, 51 Chambers St., New York City.

Fred C. Jackson, a civil engineer on the Hudson Bay Ry. in Canada, is the discoverer of the Flin-Flon Lake copper district 650 mi. northwest of Winnipeg, Man. He had never been on a prospecting expedition before October, 1915, when he staked out the present Mandy claim. The Tonopah Mining Co. of Nevada bought the claim of Mr. Jackson, agreeing to develop it and give the original finder a 15% interest. There is nearly $15,000,000 in chalcopyrite ore in sight, according to the "Engineering and Mining Journal."

OBITUARY

Robert L. Leonard, a prominent levee contractor of Memphis, Tenn., was recently killed in a railway wreck at Mounds, Ark.

Willard D. Johnson, a former Topographer of the United States Geological Survey, Washington, D. C., committed suicide Feb. 13.

Dr. Henry Dwight Holton, Secretary of the Vermont State Board of Health for many years, died at his home in Brattleboro, Feb. 12, aged 78 years. He was a Past-President of the American Public Health Association.

William Lyon Mackenzie, M. Can. Soc. C. E., Bridge Engineer of the Canadian Northern Ry., died at his home in Winnipeg, Man., Feb. 8, aged 57 years. His early engineering experience was with the Canadian Pacific and Grand Trunk railways. For the past 12 years he had been Bridge Engineer of the Canadian Northern Lines West of Lake Superior.

William O. Henderer, M. Am. Soc. C. E., President of the Osborn Engineering Co., Cleveland, Ohio, died in Florida, Feb. 8, aged 50 years. He was born in Castleton, N. Y., and went to Cleveland in 1893, when he became associated with F. C. Osborn. He was elected Vice-President of the Osborn Engineering Co. in 1900 and President in 1910. He was a Past-President of the Cleveland Engineering Society.

J. G. Macklin, M. Can. Soc. C. E., for many years Engineer of the Midland division of the Grand Trunk Ry., at Peterborough, Ont., died in England, Feb. 5. He was born in England and went to Canada as a young man and his first engineering experience there was on the construction of the cantilever bridge over Niagara River, below the Falls. His last important engineering work was the planning and construction of the dam on the Richelieu River at Chambly, Que. He is survived by a son, Lieut. F. C. A. Macklin, of the Royal Engineers.

Philip F. Kennedy, Superintendent of Construction of the Post St. reinforced-concrete arch bridge, Spokane, Wash.,

which collapsed Feb. 6, was drowned Jan. 29 by falling from the falsework of the bridge. He was a graduate of the Massachusetts Institute of Technology, class of 1907, and for several years was Assistant Engineer in the office of the City Engineer of Spokane. When the contract for the new Post St. bridge was awarded to Olson & Johnson, of Missoula, Mont., the contractors employed Mr. Kennedy as Superintendent in charge. He is survived by a widow and twin sons, about 4 years old.

John Stocks, a member of the Alberta Public Utilities Commission and for many years Deputy Minister of Public Works of the Province, died Feb. 9 at his home in Edmonton, Alta. He was born in Sherrington, Que., in 1858. He joined the engineering forces which were building the Canadian Pacific Ry. in 1881. He remained with the engineer corps of this railway for 20 years. In 1901 he was appointed Assistant Chief Engineer of the Northwest Territories and in 1905 was made Deputy Minister of Public Works of Alberta. This office he held for 10 years, when he became a member of the Provincial Public Utilities Commission.

Howard A. Greene, Assoc. M. Am. Soc. C. E., Division Manager of Erection, American Bridge Co., Pittsburgh, Penn., died on Feb. 2 of pneumonia. He was born at Providence, R. I., on Sept. 15, 1860, and was a graduate of Brown University. After graduation he was engaged in construction work in various parts of the country. At the time of the formation of the American Bridge Co., he was in charge of erection in the New York district for the New Jersey Steel and Iron Co., having been in the employ of this company since 1891. In July, 1901, he was appointed Erection Manager of the Pittsburgh division of the American Bridge Co., which position he held until the time of his death. While serving in this capacity he was in charge of the erection of many important structures, and was also the inventor of a number of important erection devices that are patented. He is survived by a widow.

Eugene C. Lewis, M. Am. Soc. C. E., Chairman of the Board of Directors of the Nashville, Chattanooga & St. Louis Ry., died Feb. 13 at his home in Nashville, Tenn. He was born in Stewart County, Tennessee, June 22, 1845. His father was owner and operator of a large iron-smelting plant, and here he gained his first technical knowledge and experience. He was graduated from Chester Military Academy in Pennsylvania in 1865. His first civil engineering experience was on a railroad survey in Arkansas. Subsequently he was with the engineer corps of the Louisville & Nashville R.R. He was one of the contractors on the Cincinnati, New Orleans & Texas Pacific Ry. Following the completion of this work Major Lewis was Sales Manager and later General Manager of the Sycamore mills of the Du Pont Powder Co. He was an officer of several Tennessee companies. In 1910 he was elected Chairman of the Board of Directors of the Nashville, Chattanooga & St. Louis Ry., having previously served this company as President and General Manager of the Nashville Terminals and as President of the railway. He was General Director of the Tennessee Centennial Exposition in 1897. He was a charter member of the Engineering Association of the South and its President in 1893. He was elected a member of the American Society of Civil Engineers in 1873 and served two terms as a Director.

ENGINEERING SOCIETIES

AMERICAN CERAMIC SOCIETY.
Mar. 5-8. Annual meeting in New York City. Secy., Edward Orton, Jr., Columbus, Ohio.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Mar. 5-10. Annual meeting in New York City at McAlpin Hotel. Secy., T. A. Randall, Indianapolis.

CENTRAL ELECTRIC RAILWAY ASSOCIATION.
Mar. 8-9. Annual meeting in Indianapolis. Secy., A. L. Neereamer, Indianapolis.

NEW ENGLAND RAILROAD CLUB.
Mar. 13-17. Annual meeting in Boston. Secy., W. E. Cade, 683 Atlantic Ave., Boston.

WISCONSIN ELECTRICAL ASSOCIATION.
Mar. 15-16. Convention in Milwaukee. Secy., George Allison, First National Bank Building, Milwaukee.

NATIONAL RAILWAY APPLIANCES ASSOCIATION.
Mar. 20. Annual meeting in Chicago at Coliseum. Secy., C. W. Kelly, Kelly-Derby Co., Chicago.

ILLINOIS GAS ASSOCIATION.
Mar. 21-22. Annual meeting in Chicago. Secy., Horace H. Clark, 1325 Edison Building, Chicago.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 20-22. Annual meeting. Congress Hotel, Chicago. Secy., E. H. Fritch, 900 South Michigan Ave., Chicago.

The American Institute of Consulting Engineers has elected to the Council the following: A. M. Hunt, Lewis B. Stillwell, Wm. J. Wilgus, Gardiner S. Williams.

The Association of American Steel Manufacturers held its annual meeting in Pittsburgh on Feb. 20 at the William Penn Hotel. The secretary is Frank A. Robinson, Steelton, Penn.

The Second Annual Drainage Conference of the University of Illinois is to be held Mar. 13 to 15. The discussions will include the organization and financing of drainage districts, the surveying of drainage areas, design of systems and improved methods of construction.

The Albany Society of Civil Engineers at its annual meeting on Jan. 23 elected the following officers: President, Edward H. Sargent; vice-presidents, Ervin B. Stevenson, Austin C. Harper, Ernest G. Raynor; treasurer, Oliver W. Hartwell; secretary, Edwin S. Cullings.

American Society for Testing Materials—The annual meeting will be held as usual at Atlantic City, June 26-30, 1917. In reaching its decision as to the place and dates for the next annual meeting, the Executive Committee had for its guidance the returns from its invitation of last November to the membership at large for suggestions in that connection, which may be summarized as follows: Total number of returns, 453; favoring Atlantic City, 256; Chicago, 56; New York, 42; Washington, 18; Pittsburgh, 17; scattering, 64. As to time, 276 members favored June, of whom 175 favored the last week in June.

The Iowa Engineering Society is holding its 29th annual meeting at the present time at Ames, Iowa. In Wednesday's proceedings was a paper by C. H. Young, City Engineer of Muscatine, on "Numbering Houses and Naming Streets." In the evening following a talk on the commission-management plan of city government, by O. E. Klingaman, what is known as a first annual "Camp Fire" was held, the same being an informal hour for stories and reminiscences. This morning's session was given over entirely to business. In the evening an informal banquet will be held at the Sheldon-Munn hotel. On Friday morning the new filtration plant at the engineering experiment station of the Iowa State University will be inspected.

The American Association of Engineers scheduled a three-day meeting Feb. 8 to 10, but some of the proposed sessions were not held and the principal features were centered in an afternoon meeting on Feb. 10. The subject of engineering ethics, as a control or guide in the personal and professional activities of the engineer, and in relation to his position before the public, was presented interestingly by Prof. F. H. Newell (University of Illinois). In a paper on "Civil Service and the Engineer," by Garrison Babcock, it was stated that the civil-service system is closer to the engineering profession than is any other arm of the Government. It represents scientific principles in public enterprises and is the channel through which good engineering must enter public service. The paper was discussed by William B. Hale, of the Chicago Civil Service Reform Association. The problem of minimum qualifications for membership, which has become increasingly insistent with the growth of the association, was reviewed by N. M. Stineman (Chicago, Milwaukee & St. Paul Ry.). An abstract of this paper appears elsewhere in this issue.

The Minnesota Surveyors and Engineers Society held its twenty-second convention at Minneapolis, Feb. 7 to 9. The Engineers' Club of Minneapolis provided the social features. The Civil Engineers' Society of St. Paul held a joint meeting with the Minnesota Society on the afternoon of Feb. 8, and the Minnesota Joint Engineering Board held its annual meeting at the same time and place. This board was organized about a year ago as a coöperative movement, its membership consisting of one member from each of the chapters of the national societies and from each of the local societies in the state, and this was its first annual meeting. The Minnesota Society committee reports on drainage and sanitation attracted attention, due to pending state legislation which would place all drainage matters under a bureau of drainage, whose head would be a civil engineer reporting to a Director of Public Domain, and which would reorganize the state board of health, reducing the number of members from nine to five and placing considerable power in the hands of a director (not necessarily a doctor). The subjects and authors of some of the technical papers were: "Third Avenue Bridge, Minneapolis," by F. W. Capellen, city engineer; "Minneapolis Industrial District" (ideal industrial sites, with trackage), by L. H. Brittin, general manager; "Designing the Largest Locomotive Crane," by Gordon Beulke, American Hoist and Derrick Co., St. Paul; "Water-Service Connections," by Garrett O. House, superintendent, Water Department, St. Paul; "Development of Water Power at Minneapolis," by R. D. Thomas, engineer, St. Anthony Water Power Co. The officers elected for the ensuing year are: John Wilson, President, Duluth; C. H. West, Vice-President, St. Cloud; T. D. Sterling, Secretary, St. Paul; W. F. Rosenwald, Treasurer, Madison.

Appliances and Materials

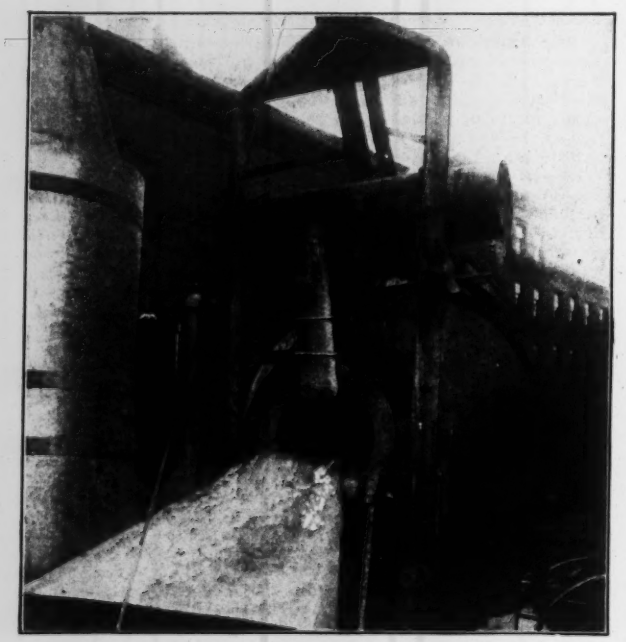
Automatic Temperature Controllers

A new line of automatic controllers for closely regulating the temperature of industrial furnaces (gas- or oil-fired or electric heated), etc., has been developed by the Bristol Co., of Waterbury, Conn. The new system comprises three elements: (1) The temperature-measuring instrument, which may be any one of the well-known types of Bristol pyrometers or thermometers; (2) the contactor, which is a newly patented circuit-closing device operated at predetermined maximum and minimum points by the pyrometer or thermometer mechanism with which it is combined; (3) the furnace regulator, which is either a pair of electrically operated air and gas valves or a relay switch for electric furnaces. These controllers are furnished for all work up to 3000° F.

* * *

Oil Burner Heats Concrete in the Drum

A device for heating concrete in the drum of a mixer by means of an oil burner is produced by the Hauck Manufacturing Co., 140 Livingston St., Brooklyn, N. Y. The purpose of this apparatus, which is attached to concrete mixers as shown in the view, is to make winter concreting possible so far as the mixing is concerned. There are two types, one hand-operated and one compressed-air operated. The hand type has a 20-gal. oil-storage tank equipped inside with a powerful hand pump. The tank can be placed on the operator's platform or on the ground, as preferred. The burner used with the hand-operated heater is of the vaporizing type, burning kerosene or coal oil, and it consumes approximately 2 gal. per hr. An oil pressure must be carried of from 20 to 75 lb. A 25-gal. tank accompanies the compressed-air outfit; the



OIL BURNER ATTACHED TO CONCRETE MIXER

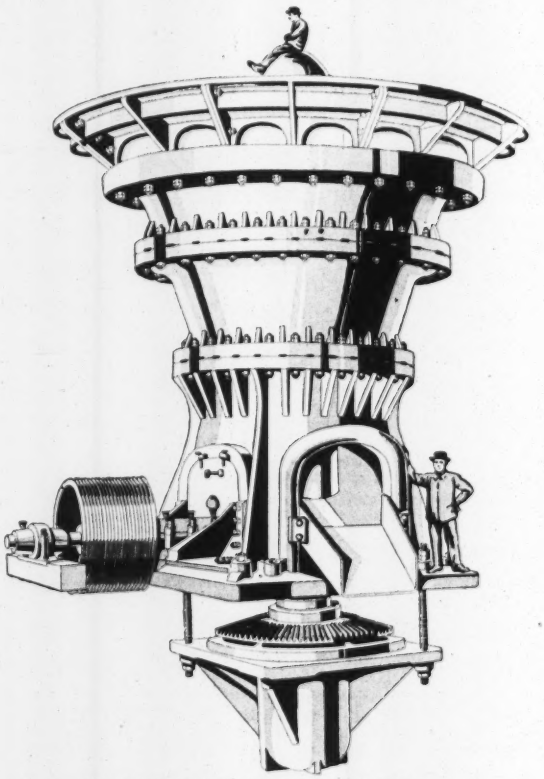
burner is of the atomizing type, requiring 15 ft. of free air per minute and burning about 1½ gal. of oil per hour. On both types the burner discharges to a steel pipe, made of oval section on the lower end so as not to interfere with the hopper. It has a short bend, so that the flame shoots diagonally into the drum.

* * *

Record-Breaking Gyratory Crusher

The world's largest rock crusher to date has been completed by the Kennedy-Van Saun Manufacturing and Engineering Corporation, of New York City, for the Michigan Limestone and Chemical Co., at Calcite, on Lake Huron, near Rogers City, Mich. The new machine will be used as a primary crusher, taking 60-in. stone and reducing to 8 in. and finer. It has a capacity for reducing 30,000 tons of limestone per 20-hour day. It is driven by a 300-hp. electric motor, through an English rope drive. The crushing space, between the head and concaves, holds 30 tons of stone. The hopper, which flares out above to a diameter of about 22 ft., affords added receiving capacity of 35 tons of stone.

The machine is 34 ft. high over all. The main shaft is 28 ft. long and 3 ft. in maximum diameter. The eccentric has a ball-and-socket bearing lined with a halved phosphor-bronze bushing on which the unit load is reduced to 175 lb. per sq. in.



HUGE NEW GYRATORY CRUSHER

The eccentric and eccentric-thrust-collar bearings are oil lubricated by a circulating pump.

The spider (a single two-arm casting) is set clear of the concaves, so that the latter can be reset without disturbing the head or spider. These concaves are made in four horizontal belts of sections to facilitate handling and so that, when worn, only those portions requiring replacement need be renewed. The top shell was too heavy to ship in one piece, so it was made in two horizontal sections with bolted, flanged, tapered, machined, male and female joints. The head is rigidly secured to the main shaft on its smooth tapered portion, being held in position by a sleeve nut fixed on, but not screwed to, the shaft. This nut operates in a follower zinked in the top of the head, so that the tendency of the head to rotate on the shaft locks the former on the latter. The main-shaft is suspended from the spider by a nut bearing on a sleeve and steel wearing ring. The head and concaves, which take the principal wear from crushing, are constructed of semisteel castings. The bevel gear and pinion are of cast steel, with planed teeth; the gear is keyed to the eccentric. The countershaft is equipped with an extra-long bearing, which is adjustable in respect to the frame of the crusher, so that by removing or inserting shims its vertical position may be regulated to adjust the gears. The bearing supporting the eccentric and gear is constructed with hardened and polished high-carbon steel wearing rings attached to the bottom plate and eccentric flange respectively, between which is a phosphor-bronze floating ring.

The stone is brought to the crusher by 8- to 10-car standard-gage trains. The broken stone from this crusher is spouted to a belt conveyor, which carries it on an upward incline to revolving screens, the rejections from which are fed to smaller crushers producing the finer sizes of stone required. It is then conveyed either to ground storage or to bins, from which it is loaded by shuttle conveyors onto specially built steamboats for transport on the Lakes to customers, principally large steel producers who utilize this limestone for furnace flux.